University of Alberta Library
0 1620 1656 5978

"SATELLITE STUDY, TROPICAL NORTH ATLANTIC, 1963"

Part II

Satellite and Conventional Data
A Daily Comparison, September 1-30

by

C.I. Aspliden

G.A. Dean

H.Landers

Department of Meteorology

Florida State University

Report No. 67-1

Prepared under Grant No. WBG 58

ESSA

National Environmental Satellite Center

Meteorological Satellite Laboratory

May 1967

ATLAS OS
QC
940
A8
A8722
1967
folio

EX LIBRIS
UNIVERSITATIS
ALBERTENSIS

"SATELLITE STUDY, TROPICAL NORTH ATLANTIC, 1963"

Part II

Satellite and Conventional Data

A Daily Comparison, September 1-30

by

C. I. Aspliden
G. A. Dean
H. Landers

Department of Meteorology
Florida State University

Report No. 67-1

Prepared under Grant No. WBG 58

ESSA
National Environmental Satellite Center
Meteorological Satellite Laboratory

May 1967

Foreword

This is the fifth of a series of reports, all of which will have the same main title but different subtitles. There are three parts, the first two of which are subdivided into three periods:

Part I. Surface Wind Analyses

July 26 - August 31 (issued September 1965)

September 1 - September 30 (issued March 1966)

October 1 - November 10 (issued October 1966)

Part II. Satellite and Conventional Data; a Daily Comparison

August 1 - August 31 (issued July 1966)

September 1 - September 30

October 1 - November 9

Part III. Special Topics

The above reports will not necessarily be issued in the order listed.

H. Landers

Principal Investigator

Acknowledgements

The research program has been sponsored by the Meteorological Satellite Laboratory of the U.S. Weather Bureau, ESSA under grants WBG 32 and WBG 58. The authors also wish to thank the many students in the Department of Meteorology, Florida State University, who carried out the detailed work necessary for the production of the maps and charts in this report; particularly Henry Cooper, Caroline Dean, Lance Hancock, William Hannon, Mokhless Mugharbel and Jack Wallace. The photographic work was done by Joseph May and David Tomlinson. Data were supplied by Marine Meteorological Offices in England, France, Germany and the Netherlands, as well as from several domestic sources within the U.S. Weather Bureau, ESSA. The manuscript was typed by Janina Richards and the draftsman was Peter Current.

We shall draw freely on the results of the extensive analysis of the IGY period in 1958, which has been accomplished by G. A. Dean under the direction of Prof. N. E. LaSeur and sponsored by the National Hurricane Research Laboratory, U.S. Weather Bureau, ESSA.

Table of Contents

	Page
Foreword	ii
Acknowledgements	iii
Table of Contents	iv
List of Illustrations	v
References	vi
Purpose	vii

Sections

1.	Introduction	1
2.	The surface maps	1
3.	Upper air analysis	3
4.	Monthly mean maps	7
5.	Satellite picture presentation	10
6.	The cloud charts	11
7.	Summary	12
8.	Catalog presentation of maps and charts	12

UNIVERSITY LIBRARY
UNIVERSITY OF ALBERTA

List of Illustrations

1. Cyclone (dashed) and anticyclone (dotted) tracks at 200 mb, September, 1963.
2. Cyclone and anticyclone tracks at 200 mb, 1-6 September, 1963.
3. Cyclone and anticyclone tracks at 200 mb, 7-12 September, 1963.
4. Cyclone and anticyclone tracks at 200 mb, 13-18 September, 1963.
5. Cyclone and anticyclone tracks at 200 mb, 19-24 September, 1963.
6. Cyclone and anticyclone tracks at 200 mb, 25-30 September, 1963.
7. Lifetime and mean motion of 200 mb vortices, September, 1963.
8. Frequency of cyclones (dashed) and anticyclones (dotted) at 200 mb in September, 1963.
9. September, 1963 mean 250 mb wind chart (knots).
10. September, 1963 mean surface wind and pressure map (knots and mb).

The illustrations appear at the end of the section to which they pertain and are not numbered as pages.

The maps and charts which form the basis of this report appear at the end in chronological order and have been assigned neither figure numbers nor page numbers.

REFERENCES

1. Aspliden, C. I., G. A. Dean, and H. Landers: Satellite Study, Tropical North Atlantic, 1963. Part I, Surface Wind Analyses, July 26 - August 31, September 1-30, October 1 - November 10. Reports to Met. Sat. Lab., U. S. Wea. Bur., ESSA, Grant Nos. WBG 32 and 58, September, 1965, March 1966, October 1966.
2. Climatological Data, National Summary, Annual 1963, Vol. 14, No. 13, U. S. Weather Bureau.
3. Aspliden, C. I., G. A. Dean, and H. Landers: Satellite Study, Tropical North Atlantic, 1963, Part II, Satellite and Conventional Data, A Daily Comparison, August 1-31. Report to Met. Sat. Lab., Nat. Env. Sat. Ctr., ESSA, Grant No. WBG 58, July, 1966.
4. U. S. Weather Bureau and U. S. Navy, 1959: Climatic and Oceanographic Atlas for Mariners, Vol. I, N. Atlantic Ocean.

PURPOSE

The conventional analyses were completed in the final form shown in the published reports for Part I and Part II (see Foreword, page ii) without reference to the satellite pictorial and radiation data. The final analyses were then compared with picture mosaics and nephanalyses of all of the satellite passes (TIROS VI and VII) available for the region. There was an average of four and one-half passes per day in August and four passes per day in September, 1963. In general there was good agreement between the conventional analyses and satellite pictures. Some of the places of apparent disagreement will be dealt with in Part III of this series of reports.

One of the main objectives of the project is to compare satellite pictorial information and analyses of satellite radiation data with two or three levels of analyses of conventional data in order to determine how they can complement each other.

1. Introduction

Part I [1] of this series of reports presented twelve-hour continuity at sea-level for the intertropical Atlantic region for August, September, October and early November, 1963. Part II presents twenty-four hour continuity at sea-level and at 200 mb plus cloud charts and mosaic presentation of satellite pictures for a considerably larger area which includes the region depicted in Part I.

Due to the size and the thickness of the Part II reports, as well as difficulties in presentation, it was decided that the text should be kept as brief as possible. The maps and charts are presented in a catalog form and no daily comments concerning intercomparisons of the charts are included. The viewer is invited to make his own comparisons.

Specific areas, periods and phenomena will be studied in considerable detail and the results will be presented in Part III (Special Topics) of this series of reports.

2. The surface maps

The streamline analyses in the region 15°-60°W, 5°S-25°N are the same as those shown in [1]. These analyses have been extended westward to 90°W longitude. African data have been added to the east of the area of the earlier analyses [1] but the paucity of data does not permit reliable analysis in that region.

The sea-level pressure field has been analyzed from 25°-46°N. The frontal positions shown were taken from the Weather Bureau's hemispheric charts which are analyzed on a current basis in the NMC in Washington. Our original pressure analyses employed a two-millibar interval, but a four-millibar interval is used in this report.

Initial plans did not call for extending the analyses north of 35°N. However, a further northward extension seemed necessary to establish vertical continuity on the Atlantic upper-level trough and its associated cyclones. In this connection, daily 500 mb analyses were also prepared but these are not presented due to space considerations and because the analyses are extremely tenuous south of 20°N in the Central Atlantic. Almost no aircraft data are present at levels near the 500 mb pressure surface.

There were several reasons for preferring an isobaric analysis north of 25°N. There is no scarcity of ship reports, geostrophic control is much more firm and a delineation of sub-synoptic or mesoscale systems was not necessary.

Surface and 2000 ft winds at coastal and island stations were used in preparing the pressure analyses but are not reproduced on the maps. Very frequently these data are the least representative to be found in regions which are mainly oceanic in nature. The maps shown herein, then, are essentially derived from ship reports. However, some land station reports have been plotted in southwestern Europe. The principal function of these and the African reports will be to provide conventional cloud information to correlate with the satellite data.

Positions of tropical depressions, storms and hurricanes north of 25°N have been taken from the track data supplied by the National Hurricane Center in Miami [2].

Although individual ships were not tracked in detail as in [1], all suspect pressure values were double-checked for position and transcription errors. As previously stated, a sufficient number of reports was available even after suspect values were eliminated.

3. Upper Air Analysis

The 200 mb surface was selected for the upper level analysis because it is representative of the high tropospheric tropical regime and aircraft data are present at high levels. As mentioned earlier, 500 mb analyses were performed also but are not presented here. A streamline analysis was considered preferable at 200 mb. A meaningful contour analysis cannot be performed due to the presence of large height errors at the 200 mb level and the small height gradients which normally exist, and below 15°N latitude the geostrophic and gradient wind concepts do not hold. Scarcity of reports also favors a streamline analysis.

Additional rawinsonde data problems are: the use of different types of instruments; the fact that all of the countries involved do not all take observations at the same time and the occurrence of systematic errors in the reports from some stations; for example, Funchal at 33°N, 17°W has temperatures and heights which are always too low. Offtime reports were plotted and used with suitable adjustments when ontime reports were absent. Some pilot balloon ascents reached the 200 mb surface and all such reports are plotted on the maps.

Analyses at 200 mb were performed also at 0000 GMT for the northern and western part of the area shown on the 1200 GMT charts to help establish and maintain continuity on upper-level systems.

Most of the jet aircraft flights between Europe and the Caribbean-S. American area provide Doppler radar wind observations as well as temperature, flight level and an occasional remark about cumulonimbus cloud activity. The observations lie between 31,000 and 39,000 feet above MSL with an average height of 35,000 feet. This average is very close to the 250 mb

surface and this surface rather than 200 mb would have been selected for the high-level analyses except for the fact that no European or African radiosonde stations report at 250 mb. The aircraft observations are generally taken at points five degrees of longitude apart (about 3/4 of an hour of flight time). A given flight may begin at 33,000 ft, rise to 35,000 ft in the mid-Atlantic and rise again to 37,000 ft near the end of its route. All of the aircraft data have been plotted on the 1200 GMT maps; that is, data from 0000 GMT to 2359 GMT for any given day. However, only the observations from 0600 GMT to 1759 GMT were used in the 1200 GMT analyses. The reader is urged to check the observation time as well as our track charts for plotted winds which do not seem to fit the streamline analyses. All observations, ± 6 hours, were adjusted for time and fit our continuity of synoptic systems. For the most part, it was assumed that little or no vertical changes in structure and position of synoptic systems occur in the 200-300 mb layer in the central Atlantic region. Some evidence to support this was presented in [3, fig. 12]. Also shown in [3] is an example of the way in which offtime aircraft reports were used.

Twenty-four hour past history is shown on the 200 mb charts for the cyclones (dashed lines) and anticyclones (dotted lines) and the present and previous positions are indicated with an x. Initial and final stages of cyclones and anticyclones are represented by cusps. The surface positions of hurricanes and tropical storms have been entered on the 200 mb charts, also the last day of the depression stage for intensifying storms and the first day of the depression stage for weakening storms. The tropical cyclone name and its stage D, S or H have also been entered. All of the above positions and classifications are from [2] north of 25°N latitude. South of that

latitude the positions may be slightly different due to a better data sample than was available for the Weather Bureau publication [2].

Data are not plentiful enough generally to determine whether the 200 mb cyclones and anticyclones have an outdraft or indraft or neither. Most anticyclones have been drawn with outdraft and cyclones with indraft. Over hurricanes we have used the model known to exist at high levels.

The tracks of the upper-level cyclones and anticyclones have been kept as simple as possible. However, much circling and looping is present in the tracks due to the fact that many of these systems are nearly stationary for long periods of time. Figure 1 shows the tracks of all detectable cyclones and anticyclones in the area for the entire month of September. Figures 2 through 6 show a breakdown of the tracks into six-day periods. Due to scarcity of reports and the fact that only one report per day comes from most African stations, no tracking has been attempted for cyclones and anticyclones south of about 12°N over Africa and the eastern Atlantic.

In general, the cyclone tracks lie close to the mean position of the upper level trough which crosses the Atlantic from about 20°N on the western side to about 35°N on the eastern side. The cyclones near the western end of the trough tended to move toward the west, some moving into Mexico and Central America. In the central Atlantic the cyclones tend to execute loops rather than moving systematically in any specific direction and their lifetimes were shorter than in August [3, page 6]. Only two exceeded three weeks and one other exceeded two weeks. The cyclones in the eastern part of the Atlantic again show a general tendency to move eastward. Again some cyclones appeared in the area just east of Trinidad and they are

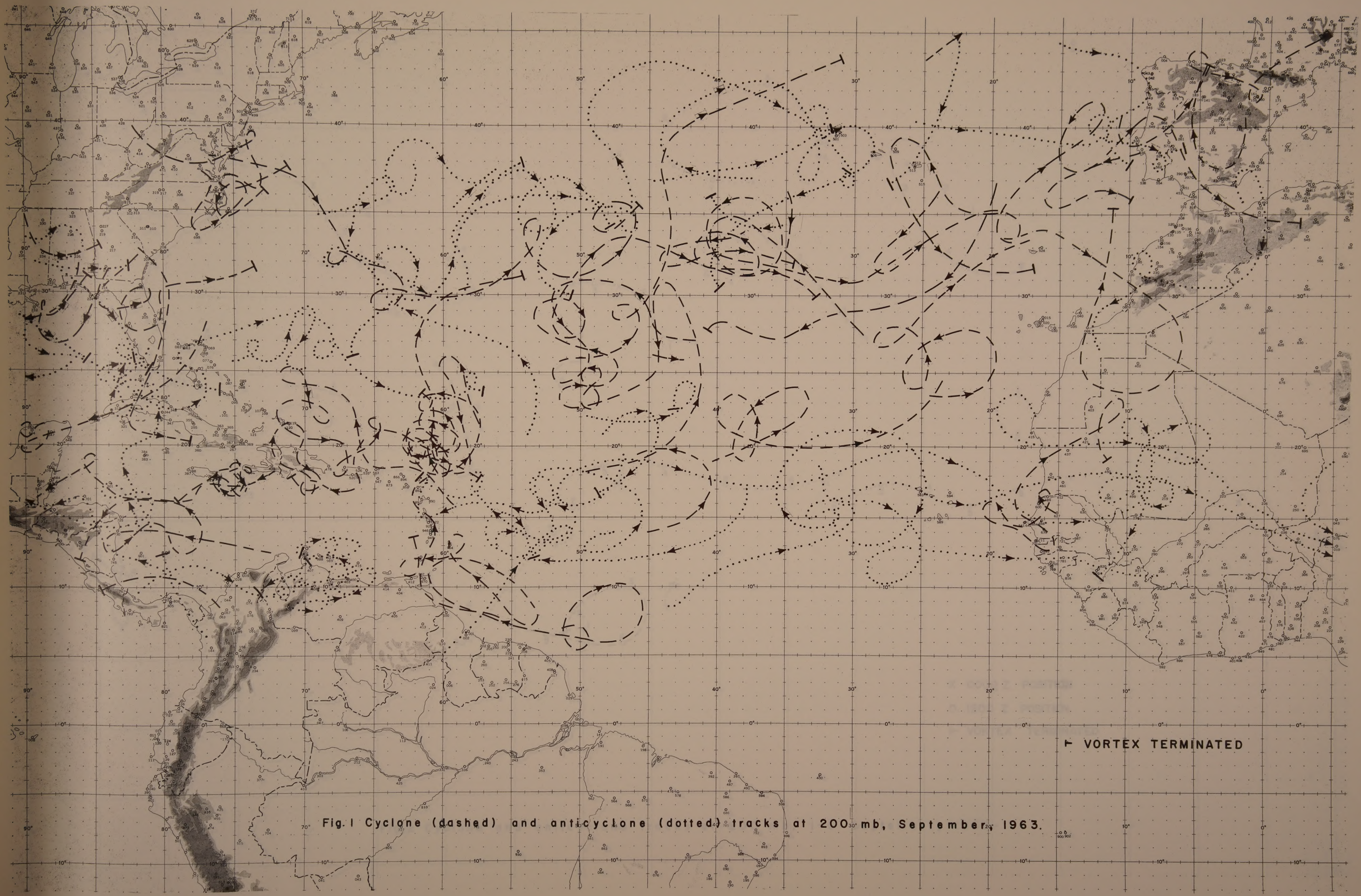


Fig. 1 Cyclone (dashed) and anticyclone (dotted) tracks at 200 mb, September, 1963.

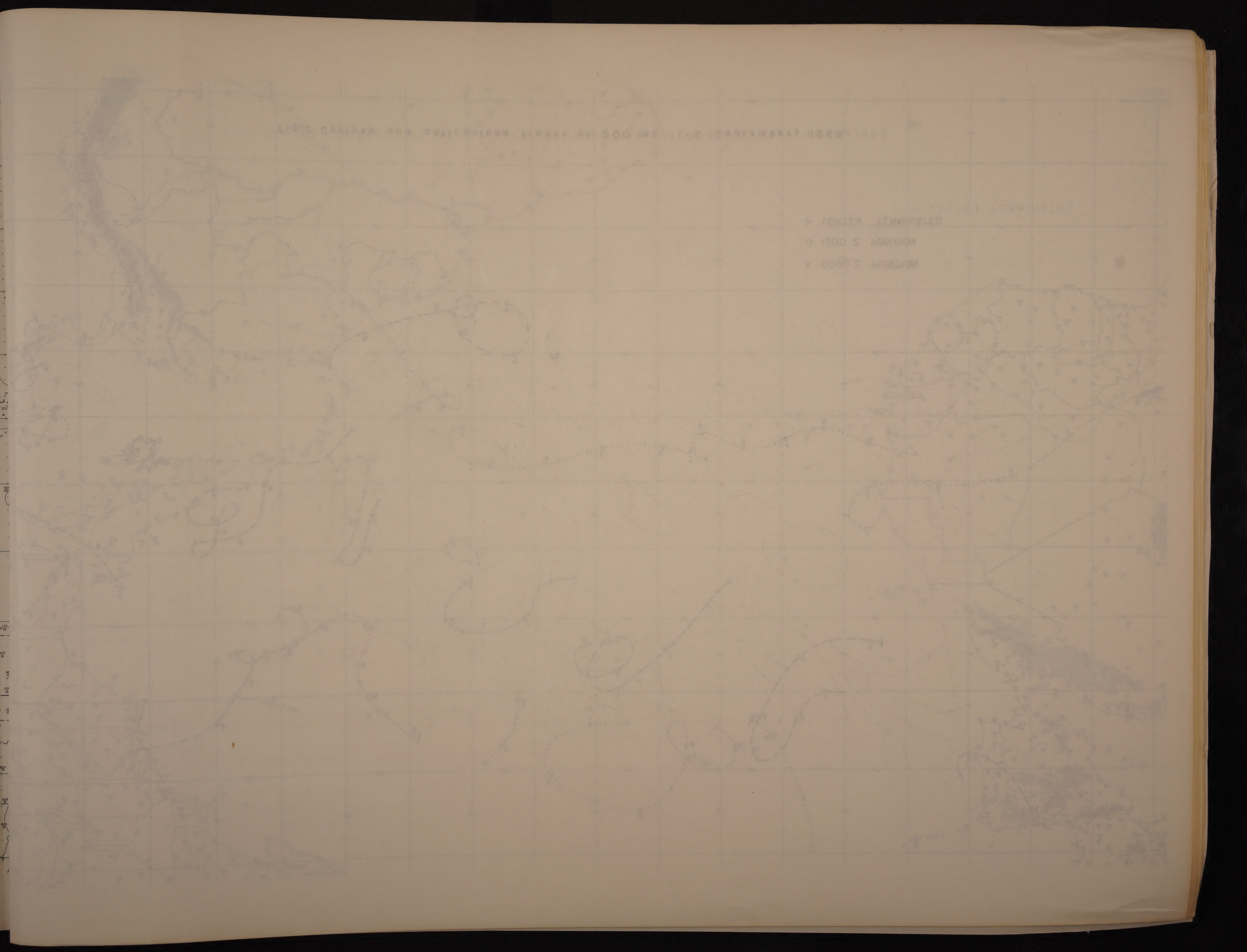
← VORTEX TERMINATED

X 0000 Z POSITION

O 1200 Z POSITION

⊢ VORTEX TERMINATED

Fig.2 Cyclone and anticyclone tracks at 200 mb, 1-6 September, 1963



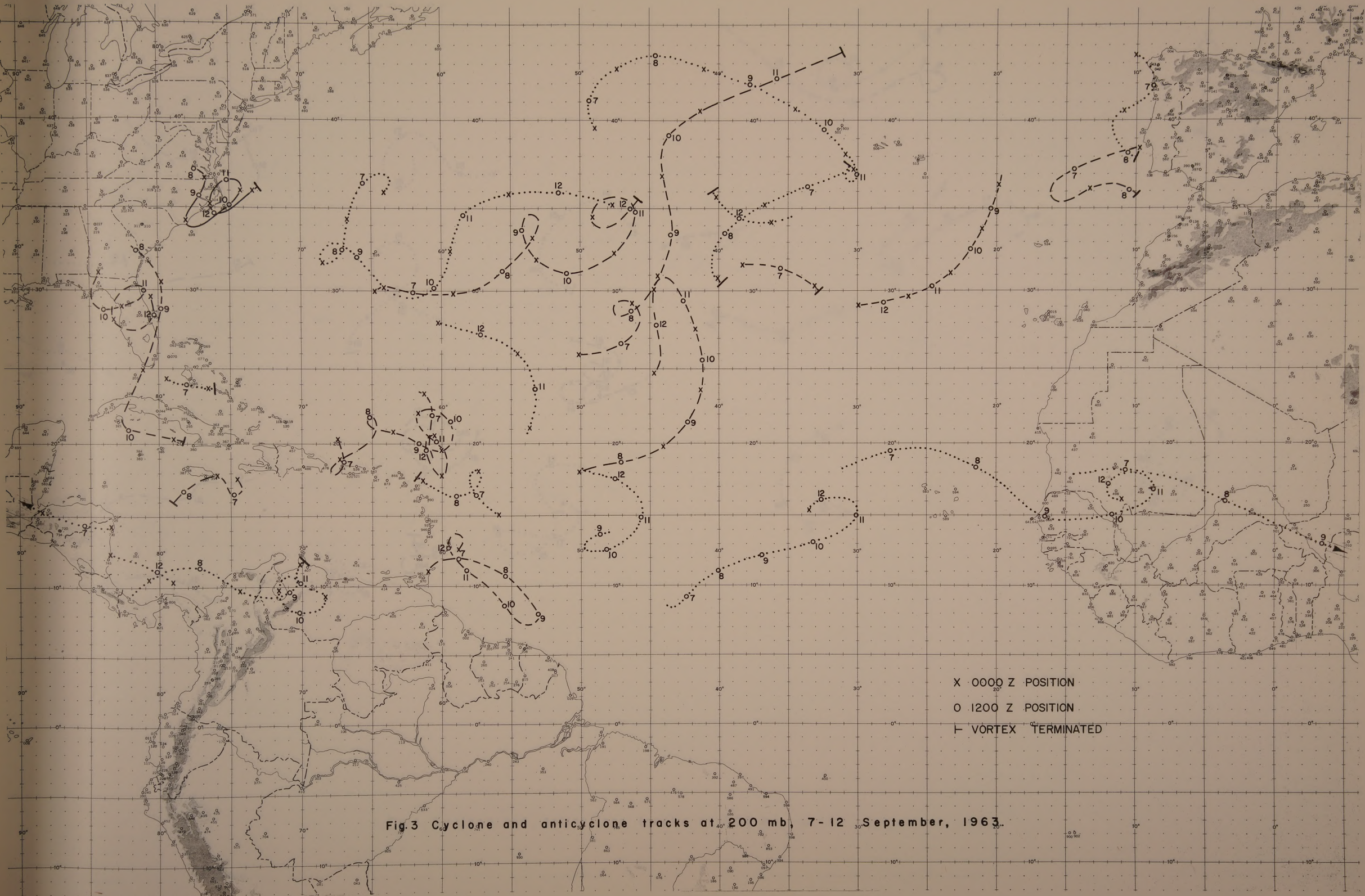


Fig.3 Cyclone and anticyclone tracks at 200 mb, 7-12 September, 1963.

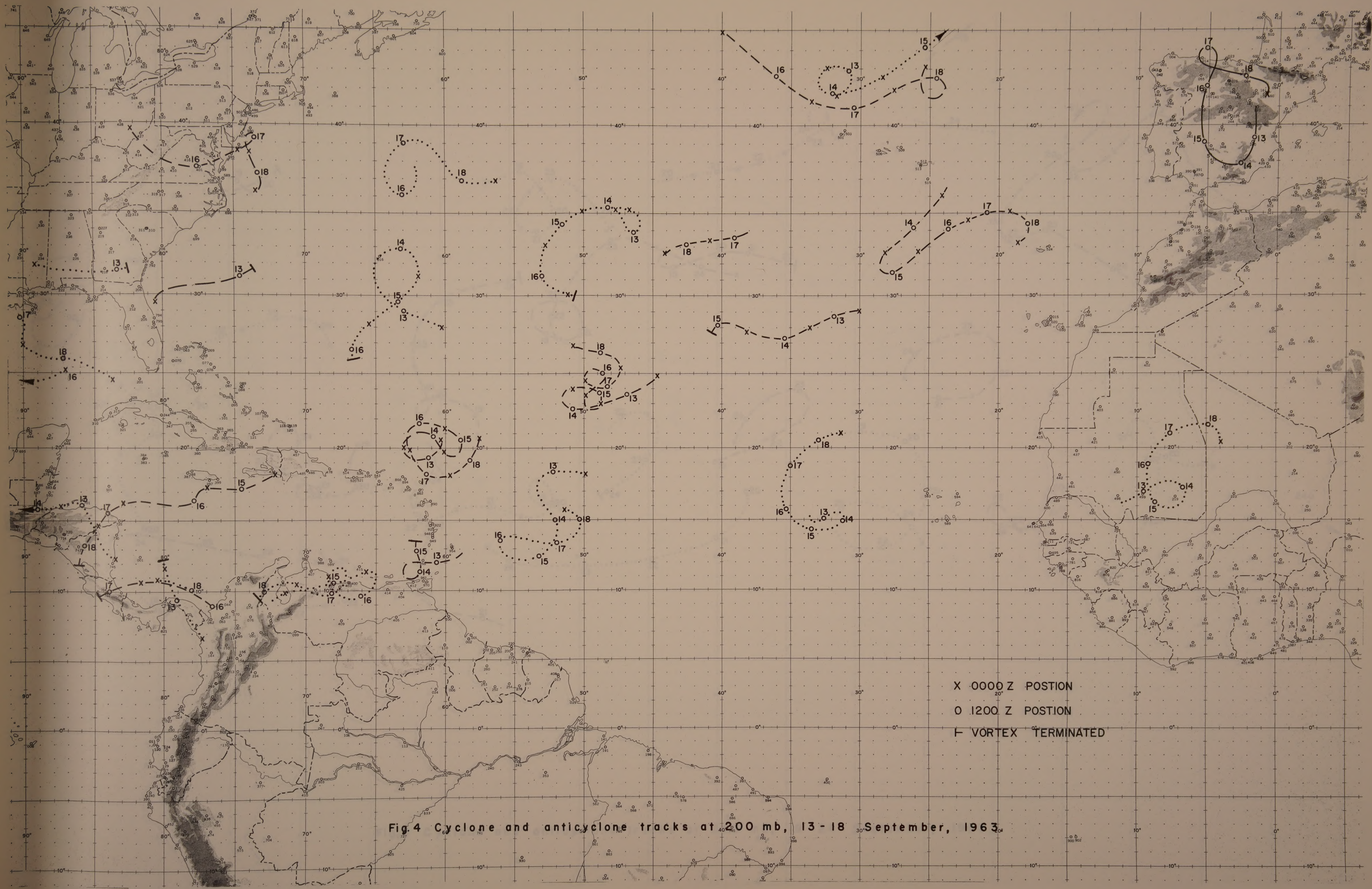
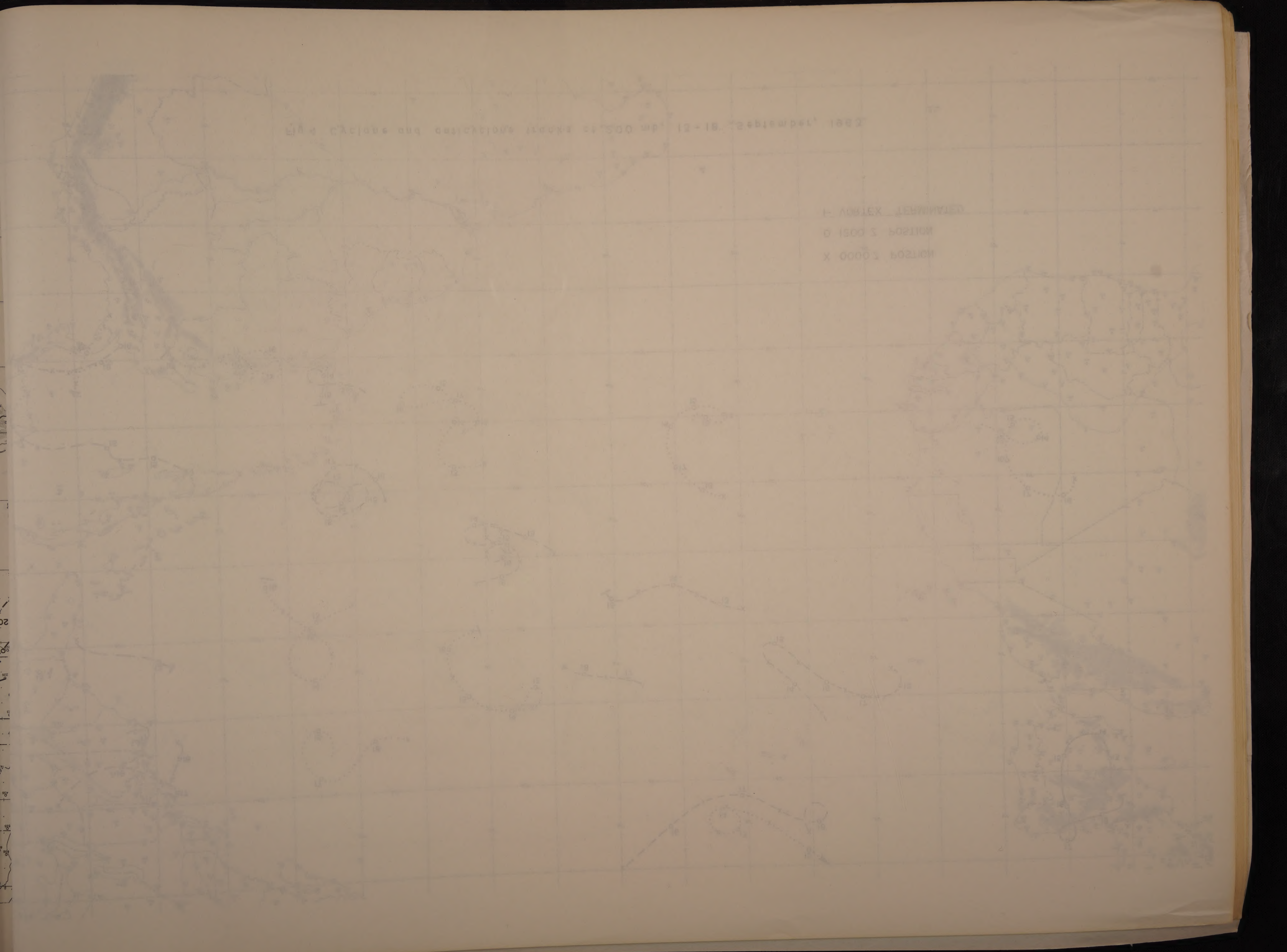


Fig. 4 Cyclone and anticyclone tracks at 200 mb, 13 - 18 September, 1963.

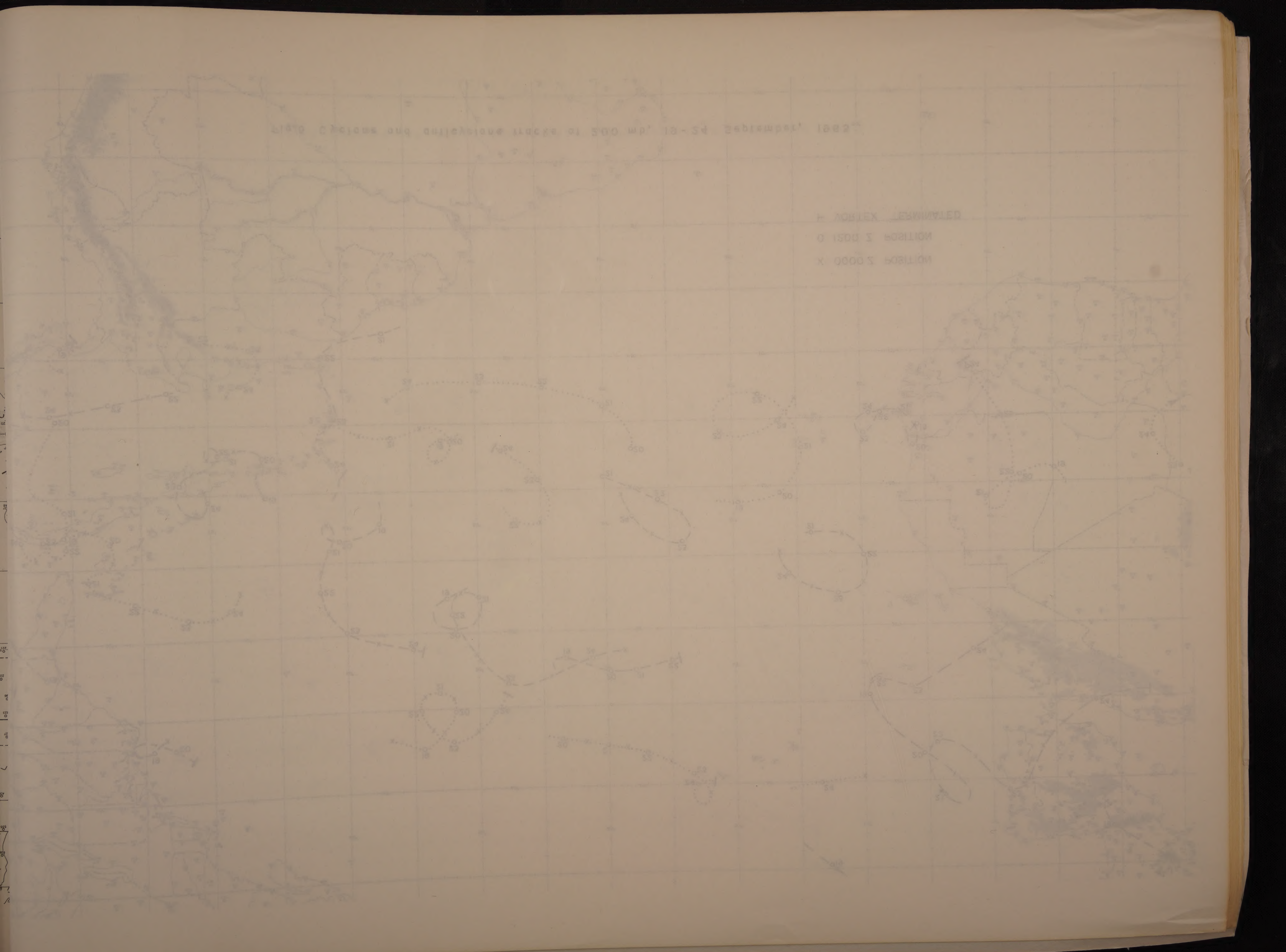


X 0000 Z POSITION

O 1200 Z POSITION

⊢ VORTEX TERMINATED

Fig. 5 Cyclone and anticyclone tracks at 200 mb, 19 - 24 September, 1963.



X 0000Z POSITION

O 1200Z POSITION

F VORTEX TERMINATED

Fig. 6 Cyclone and anticyclone tracks at 200 mb, 25 - 31 September, 1963.

associated with a west-northwestward extension of the high-level southern hemisphere anticyclone belt, and have, of course, the same counterclockwise rotation as these anticyclones. There were two of this type in September 1963 and they moved generally toward the northwest. Figure 7 illustrates the mean speed and direction and the lifetime of the 200 mb vortices. The circles shown with the arrows attached and numbers underneath are the mid-point positions between point of origin and point of dissipation of each system. The arrow shows the mean direction of motion and the length of the arrow the mean speed of motion throughout the life-time of the systems. The numbers indicate how many days during September, 1963, that the systems appeared on the 200 mb charts, and the numbers are underlined for all vortices which continued into October. Roughly speaking the cyclones east of the 50°W meridian move east, those west of there move west. Speed of motion of the cyclones and anticyclones varied from 7° lat/day to 1/3° lat/day; their lifetimes from two to twenty-four days.

There are three main anticyclonic belts and we follow the nomenclature introduced earlier (in the Pacific) by C. E. Palmer and others of the Oahu Research Center. The descriptive titles apply more closely in the mid-Pacific, however, where all of these belts are found about 5° of latitude farther south. The belt which lies roughly between the equator and 10°S in the Atlantic is the "southern hemisphere" anticyclone belt, the "equatorial" anticyclone belt extends from 14°N near the Lesser Antilles to 17°N over west Africa and the "subtropical" anticyclone belt extends from about 34°N at 50°W to about 38°N in the Azores. The cell in the latter belt which was found just southwest of Bermuda (65°W) in August appears only as weak anticyclonic curvature in September. The positions mentioned above can be seen more clearly

in figure 9.

Some attempt was made to keep continuity on the "southern hemisphere anticyclone but the results were so tentative that they have not been included on the track charts. There are three main anticyclonic centers in the "equatorial" belt. The one over Africa is located about halfway between the positions of the two African anticyclones found in August. The other two anticyclones are over the Atlantic at about 30° and 52° west. All three are fairly persistent and remain in the same area as did their August counterparts, although there is some tendency for those over west Africa to move eastward. In general, the "subtropical" anticyclones tend to move eastward but very slowly and erratically. The details of the motions of the anticyclones and cyclones are documented in figures 1-7.

4. Monthly mean maps

A map of cyclone and anticyclone frequency per 5° lat-long square at 200 mb was constructed, figure 8, and served as an aid in the positioning of the closed systems on the 250 mb September mean map. The numbers on figure 8 represent the number of days out of 30 that a cyclone or anticyclone appeared at 200 mb in a given 5 degree square. Dotted lines are used for the isopleth analysis of anticyclone frequency, dashed lines for cyclones.

In the "subtropical" anticyclone belt, except for the center just west of the Azores, there is an east-west elongation of the centers of highest frequency due to the motion of the systems. Although the anticyclonic frequency is less than in August [3] in the Bermuda area, there is a noteable extension of the belt through that area to a center over Key West. The lesser amount of the east-west elongation of centers in the "equatorial" anticyclone belt

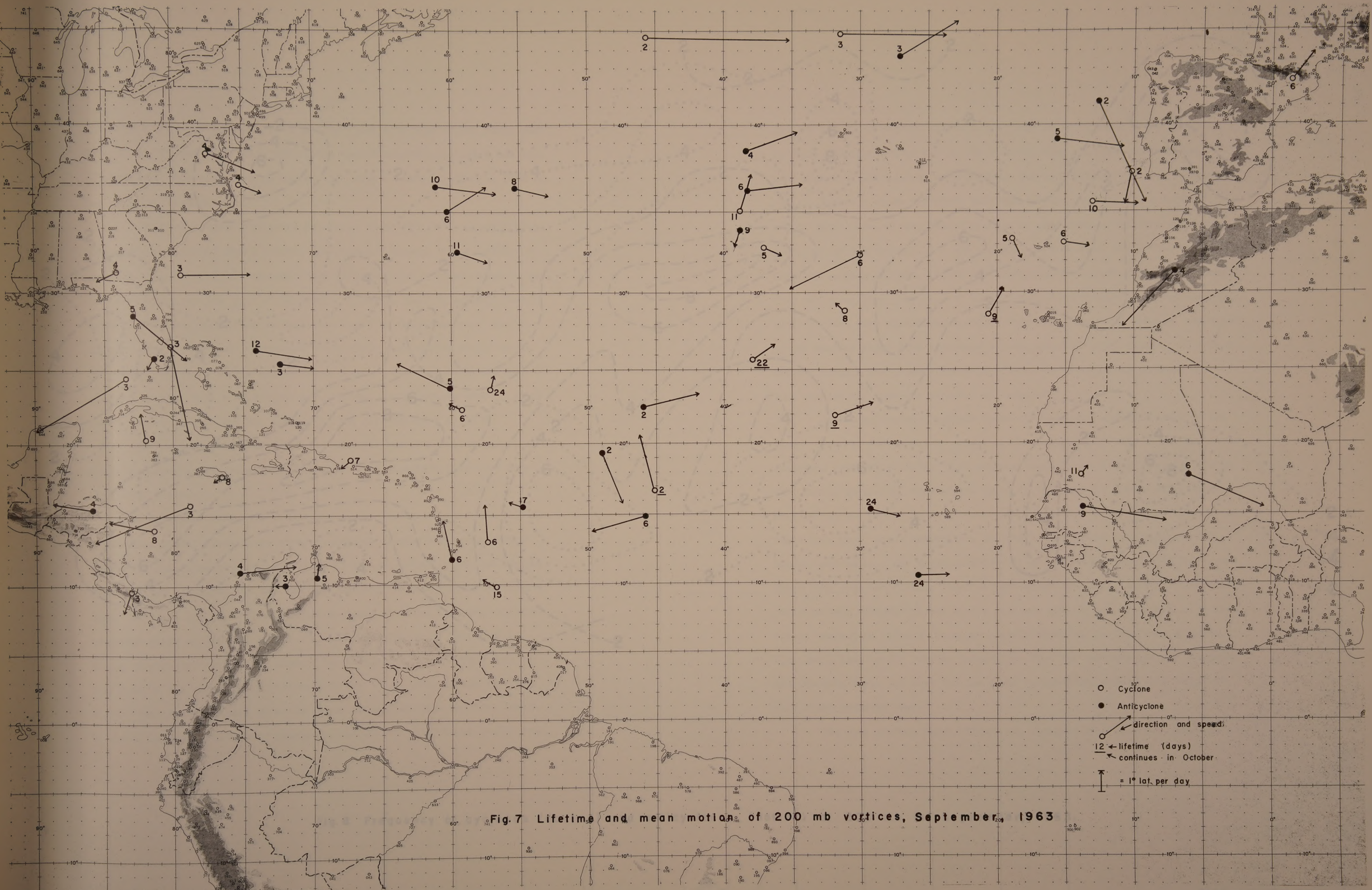


Fig. 7 Lifetime and mean motion of 200 mb vortices, September, 1963

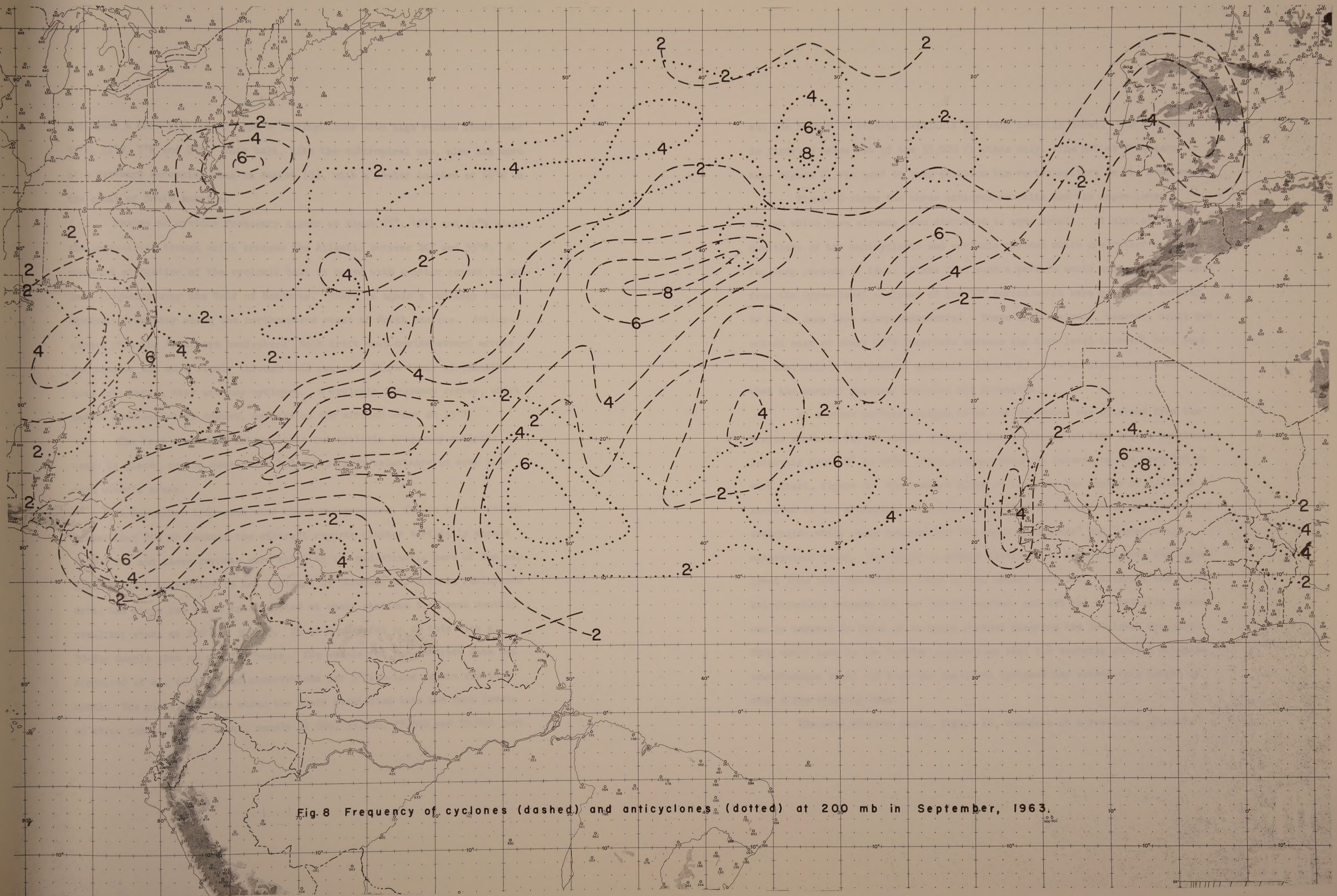
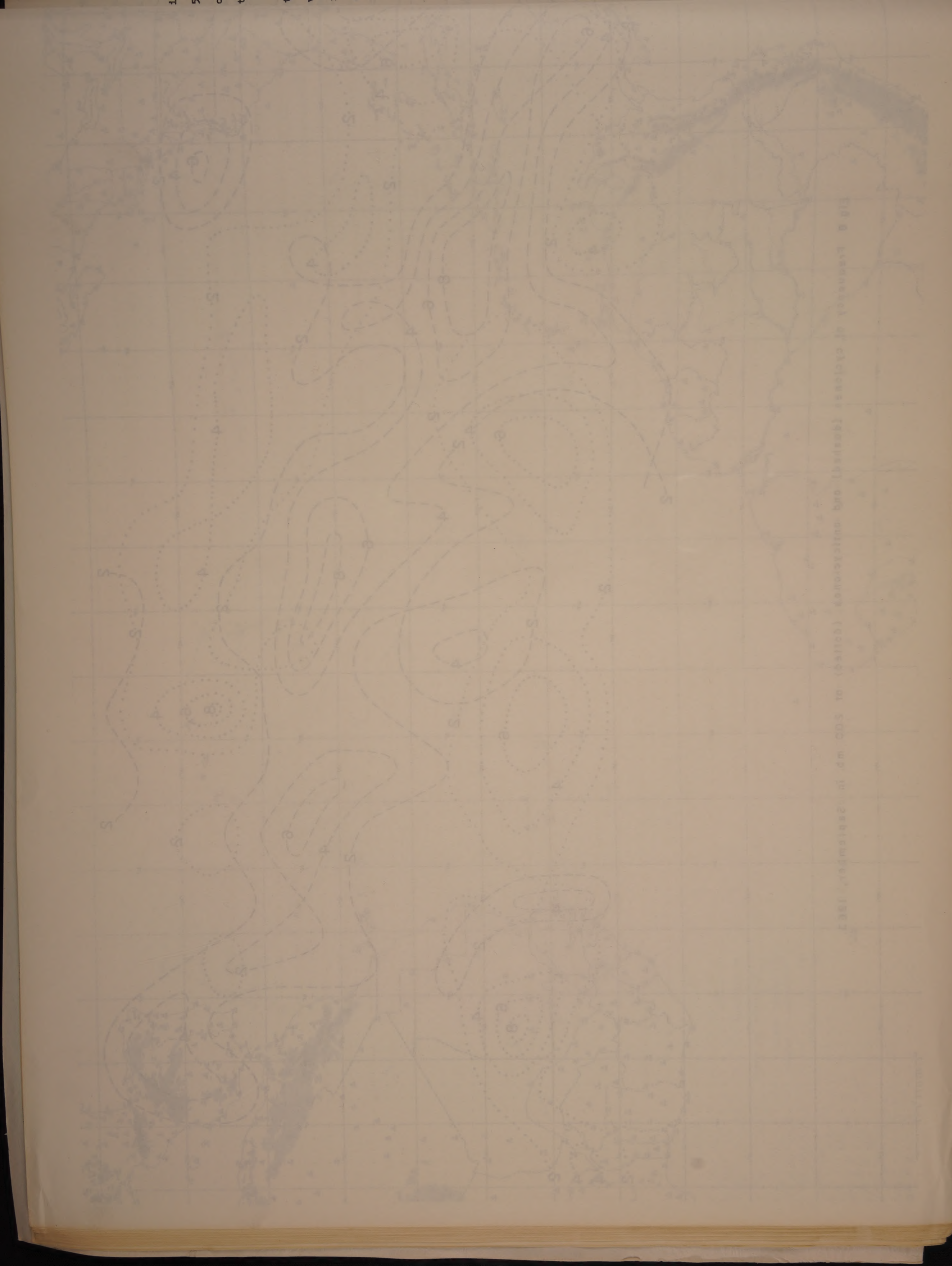


Fig. 8 Frequency of cyclones (dashed) and anticyclones (dotted) at 200 mb in September, 1963.



indicates a more stationary type of anticyclones with high values found near 52°W, 31°W, 7°W and 3°E. This belt, like the subtropical one, also has more of a westward extension than in August [3], with a center located at 68°W on the coast of South America.

Maxima of cyclone frequency appear at about 65°, 42° and 24°W along the upper-level trough which crosses the Atlantic between 20° and 35°N. A westward elongation of the cyclonic belt is noted with another center of maximum frequency over the Gulf of Honduras. There is again a tendency toward cyclonic frequency along the northeastern coast of South America. Anticyclones from the "southern hemisphere" belt drift west-northwestward across the equator and move slowly through this region. Since their circulation does not change, they are now cyclones. A cyclonic frequency center, which had no counterpart in August, appears on the African coast at 15°N.

The fact that both anticyclonic and cyclonic frequency analyses could be placed on the same chart indicates their reluctance to move into each other's areas.

A September 1963 mean wind chart was prepared, figure 9, for 250 mb rather than 200 mb because the aircraft reports cluster vertically around 35,000 ft, and these reports were vital to the mid-Atlantic part of the map. Since the 250 mb surface is not included in European and African rawinsonde data, the winds had to be interpolated at these stations from mean monthly resultant winds at 200 and 300 mb. It is much safer to do this with a 30-day sample than on a daily basis. The sample for the aircraft data was comprised of all of the wind observations per 5° lat-long square for the month. The plotting model shows the winds stratified into the four levels at which these reports occur, namely 31,000, 33,000, 35,000 and 39,000 feet.

and the number of reports available for each level is shown. The analysis in figure 9 makes use of the 35,000 ft winds only. The 200 mb frequency map, figure 8, was used to help position the vortex centers on the mean map.

Figure 9 shows the three anticyclone belts and the upper-level trough which have already been discussed in some detail. It also shows the positions of the anticyclonic and cyclonic systems which are rather stationary for long periods of time. Hints that such a pattern would evolve were gleaned from the upper-level analyses of the IGY period which were performed earlier by G. A. Dean (see acknowledgements). These 1958 analyses, however, could not extend east of about 60°W longitude because the high-level aircraft data were not available. The present analysis, figure 9, shows no disagreement with what the earlier analyses revealed and suggested.

An average surface cyclone track for September was obtained from the tracks shown in [1] by simply averaging the latitudes at five degree longitude intervals from 20° to 60°W. This average track is entered on the mean 250 mb wind chart, figure 9. The numbers along it indicate the number of cyclones involved in the averaging. The track lies beneath a broad band of upper-level easterlies which occur between the "southern hemisphere" and "equatorial" anticyclone belts. The track is almost identical in direction with the upper-level flow from the African coast to the Lesser Antilles. Although the vertical structure between the two levels (surface and 200 mb) is virtually unknown one is tempted to think of an upper current steering the low-level cyclones. This would lead to the further suggestions that the easterly current occupies considerable depth and that the low-level cyclones may extend to a height of only a few thousand feet.

The mean surface chart, figure 10, consists of a sea-level pressure

RADIOSONDE STATION

DOMESTIC

TT.T HHH

ddd f.f.f

FOREIGN

N (if less than 30)

ddd f.f.f PPP

AIRCRAFT DATA

N- ddd ff.f-HH

(HH is thousands of ft.)

Fig. 9 September, 1963 mean 250 mb wind chart (knots).

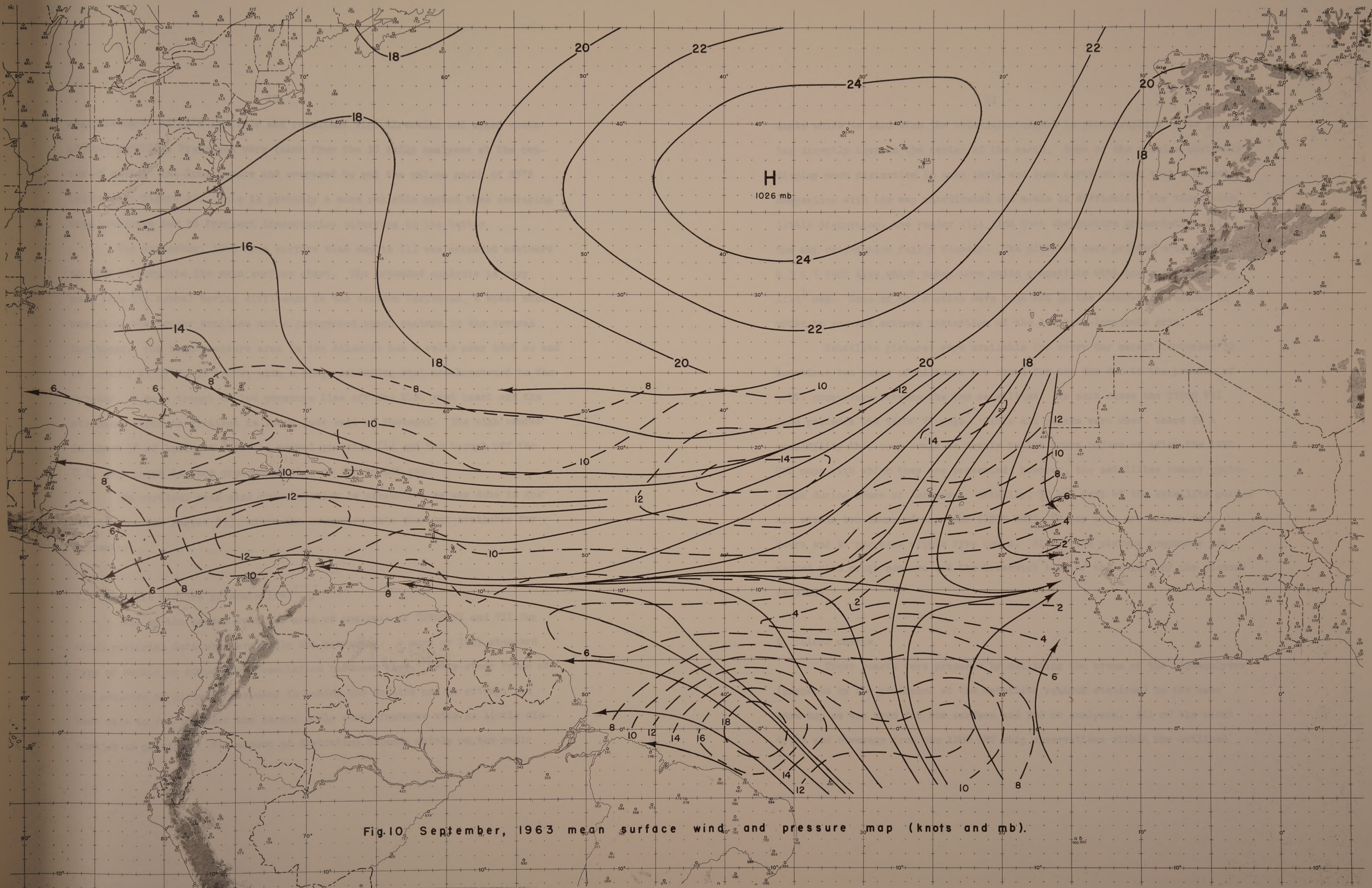
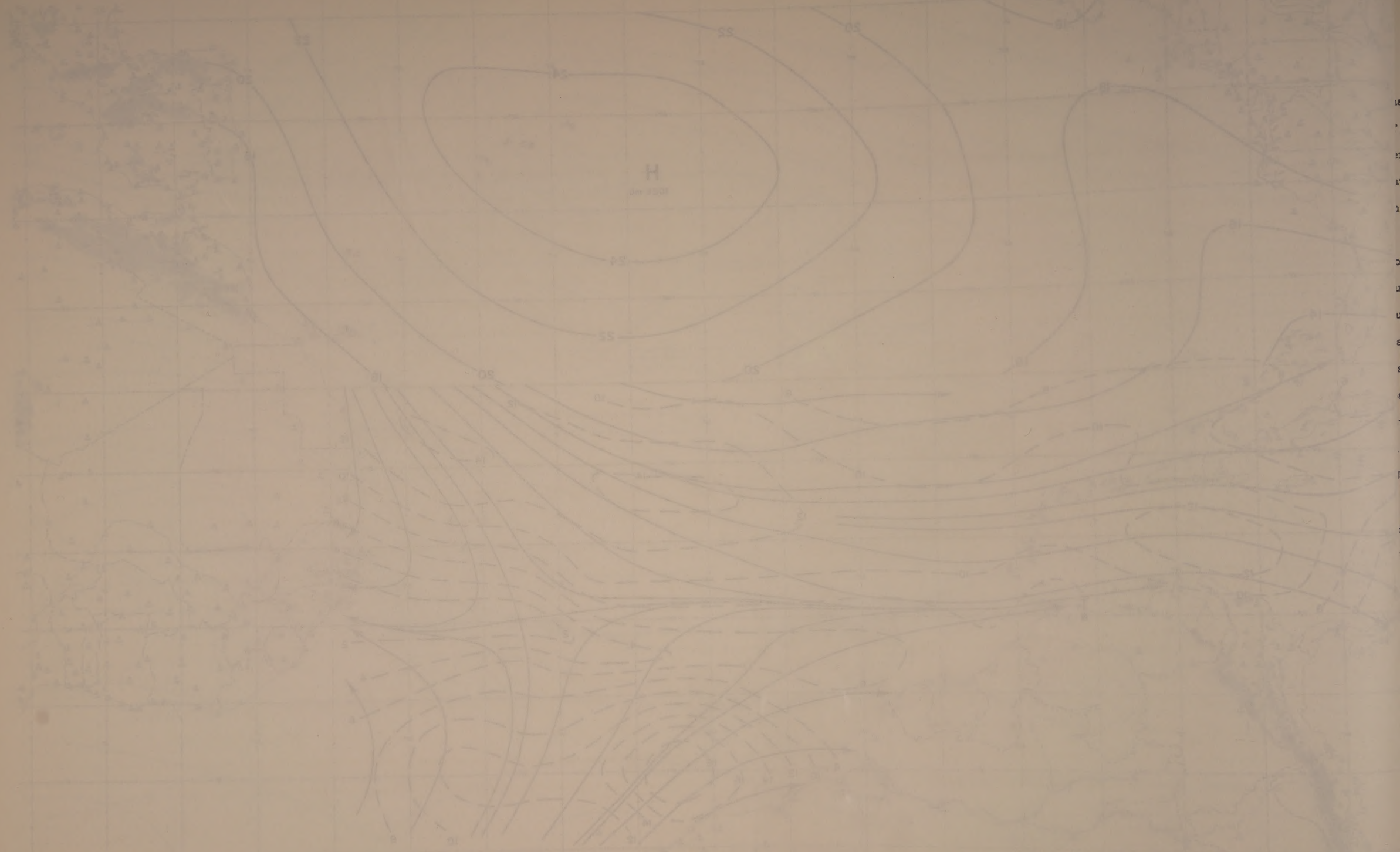


Fig. 10 September, 1963 mean surface wind and pressure map (knots and mb).



analysis north of 25°N latitude and resultant wind direction and speed south of that parallel. Pressures were taken from the 30 daily analyses at the center of each 5° lat-long square and averaged to get the values north of 25°N latitude in figure 10. This is probably a more reliable method than averaging ship pressures due to frequent inaccuracies occurring in the latter

The September, 1963 mean surface wind map in [1] was extended westward to 90°W to complete the mean surface chart. The extended analysis is very much like the normal having diffluence in the western Caribbean, a speed minimum along the Lesser Antilles and a pronounced speed maximum in the central Caribbean. The high-pressure area in the Atlantic has a value near 1026 mb and is located at 37°N, 36 1/2°W, with a ridge extending west-southwestward to the Bahamas. A mean trough of low pressure lies off the U.S. east coast and the strongest pressure gradient is found just west of Portugal. The high center is about 3° of latitude N of the normal position [4] and the trough off the U.S. east coast is more pronounced than on the normal map.

No vertical mean wind cross-section is presented, as was done in the publication for August [3], since the necessary data were not available for September.

5. Satellite picture presentation

All of the passes over the area of analysis of TIROS VI and VII for which pictorial data were available are presented. A more or less standard type of mosaic or composite presentation has been used. Every other frame of the sequence of pictures was used in making the mosaics and an attempt has been made to fit together the larger scale cloud features with as little distortion as possible. The amount of distortion depends mainly on the nadir

angle which is zero when the television camera is photographing while pointing directly towards the center of the earth. Some of the mosaics obviously display much distortion in some parts and some curve so much that a direct comparison with the map coordinates and scale is difficult. For those with little distortion, the reader will find that the picture presentation fits the map orientation fairly closely. The pictures were printed originally in a 5 x 7 inch size which makes them quite compatible with the scale of the $1:10^7$ map. Some of the mosaics have been cut in the cloud-free regions in order to prevent extreme distortion of the latitude-longitude grid.

Satellite pictures were available for every day except September 30. Sometimes two pages of pictures are shown for one day due to the problem of orbit crossovers between the two satellites. In such cases the TIROS VII page precedes the TIROS VI page. Since all passes were used, there is a possibility that some could be nearly twelve hours before or after the 1200 GMT maps with which they are presented; however, the satellites cannot photograph during hours of darkness. Actually, 50 per cent of the satellite passes are within two hours of map time (1200 GMT), 82 per cent are within four hours and 91 per cent within five hours. All of the picture sequences are marked with orbit numbers and the Greenwich time of the center of the picture sequence.

6. Cloud charts

These charts were prepared by outlining the areas of the nephanalyses (prepared by the personnel at the satellite readout stations) on the same base map as was used for the surface and 200 mb analyses. All of the cloud types and coverage from the 1200 GMT ship observations within the outlined

areas were plotted on these charts. The reader should not infer that clouds do not exist in other areas on the maps, but since satellite pictures were not present we have not presented cloud data outside the nephanalyses regions.

The conventional symbols have been used for clouds and sky coverage. If no satellite pictures were present on a given day, no cloud map appears for that day.

7. Summary

The material presented herein probably has value in at least three important ways.

First, it presents all of the satellite picture information for a period which had fairly good coverage with a rather detailed and complete analysis of the conventional data for the entire Atlantic tropical storm region for the second month of the storm season in 1963.

Second, it adds considerably to our growing fund of knowledge concerning the existence and behavior of the circulation features of the high troposphere in the tropical and subtropical Atlantic region.

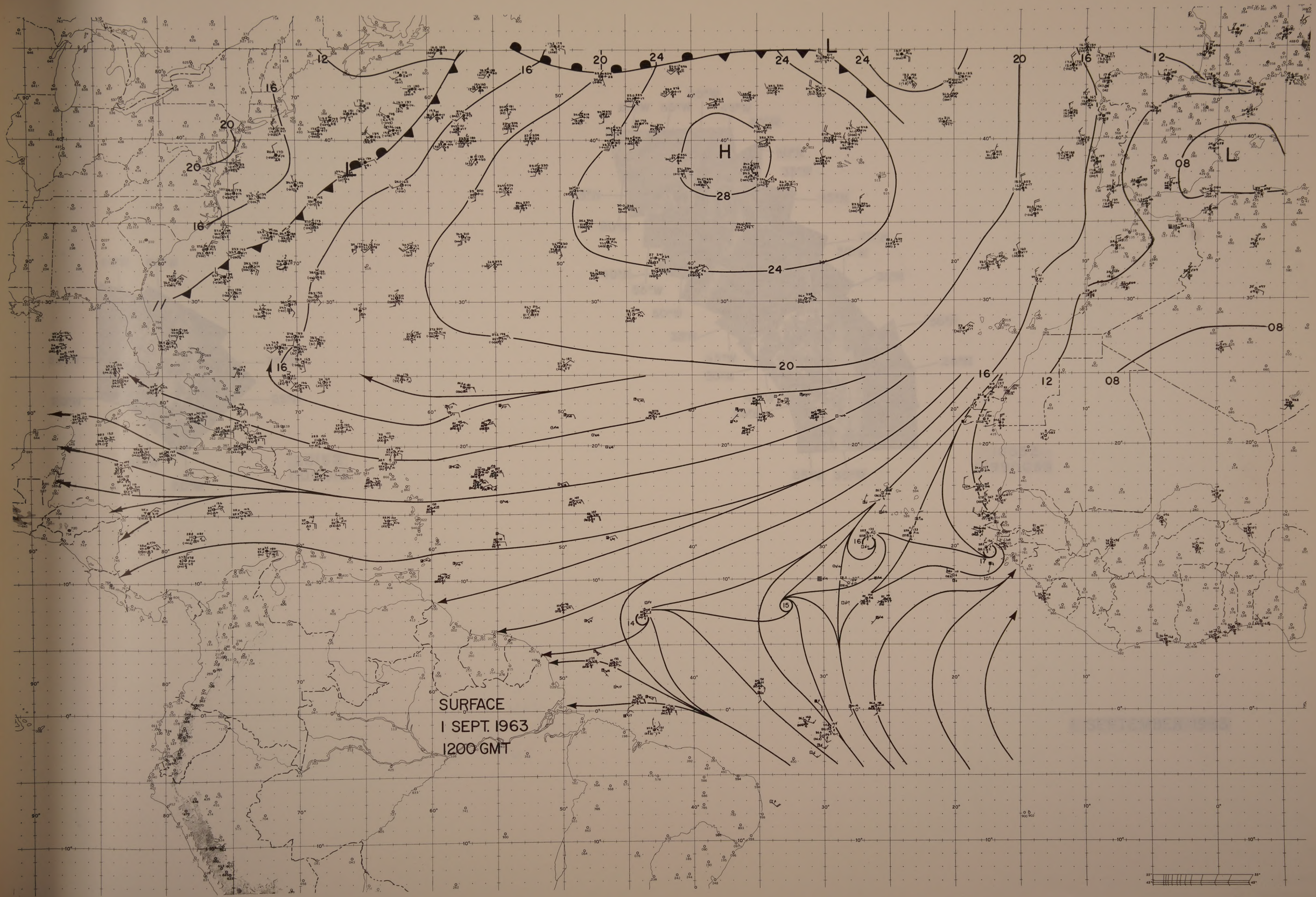
Third, it indicates that the average surface cyclone track lies in the middle of an east-to-west flow at 200 mb and that this track is oriented along the 200 mb streamlines. This suggests at least that the low-level cyclones give way (at some height) to an easterly current aloft which strongly influences their average direction of motion.

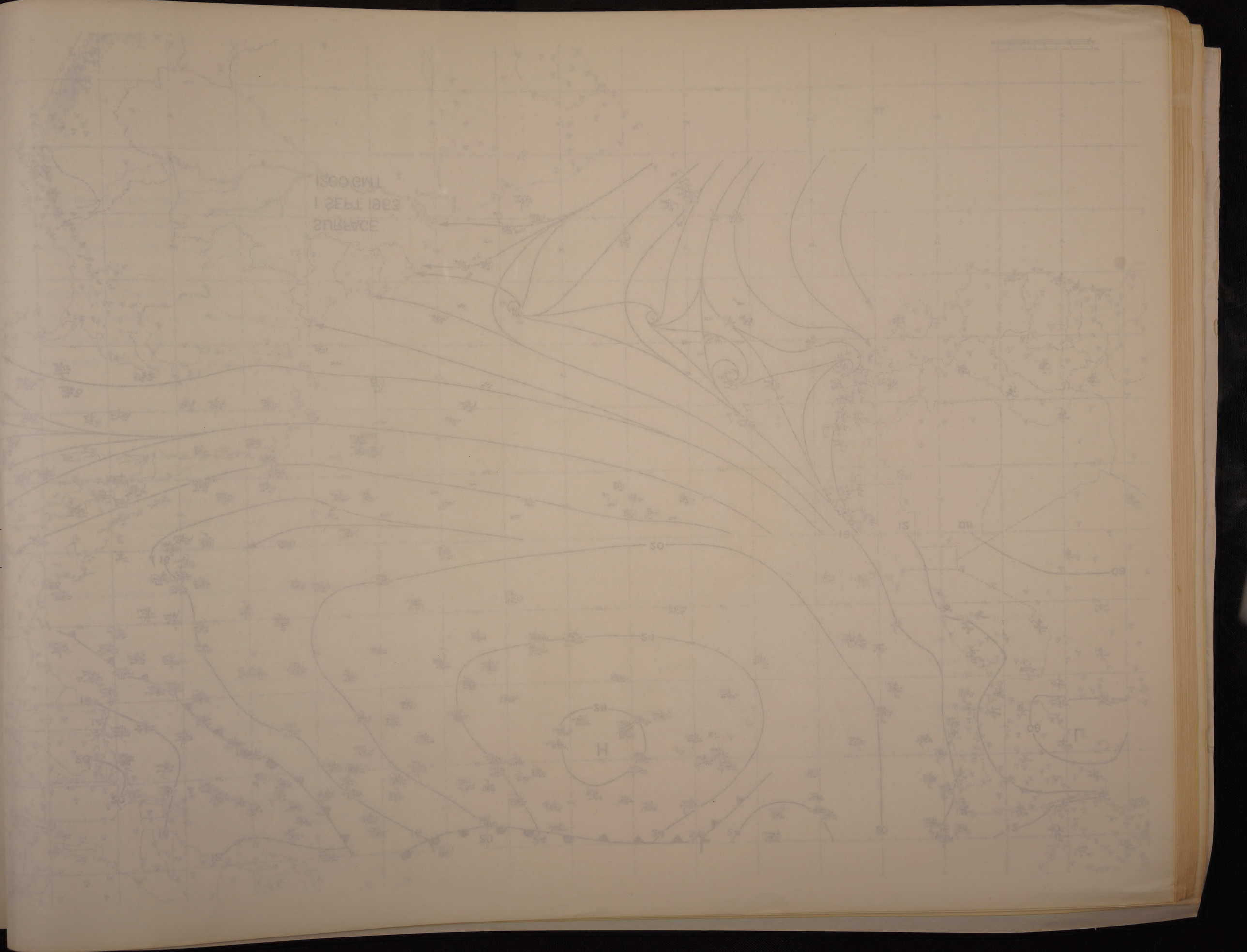
8. Catalog presentation of maps and charts

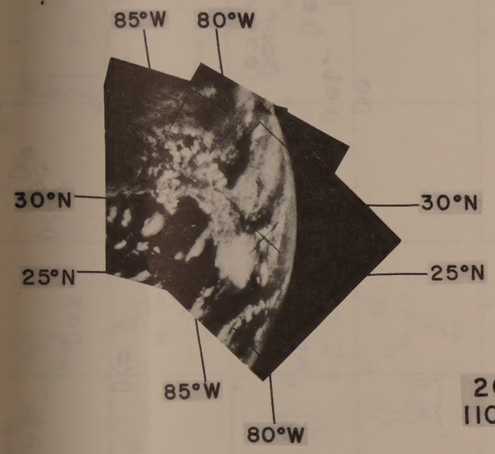
Two or more charts are presented for each day of September, 1963. The surface chart is first and the 200 mb chart last on each day. On

September 30th these are the only charts that appear. On all other days the satellite picture mosaic presentation is placed second, the cloud chart third and the 200 mb chart fourth. On some days two pages of mosaics of satellite pictures are present.

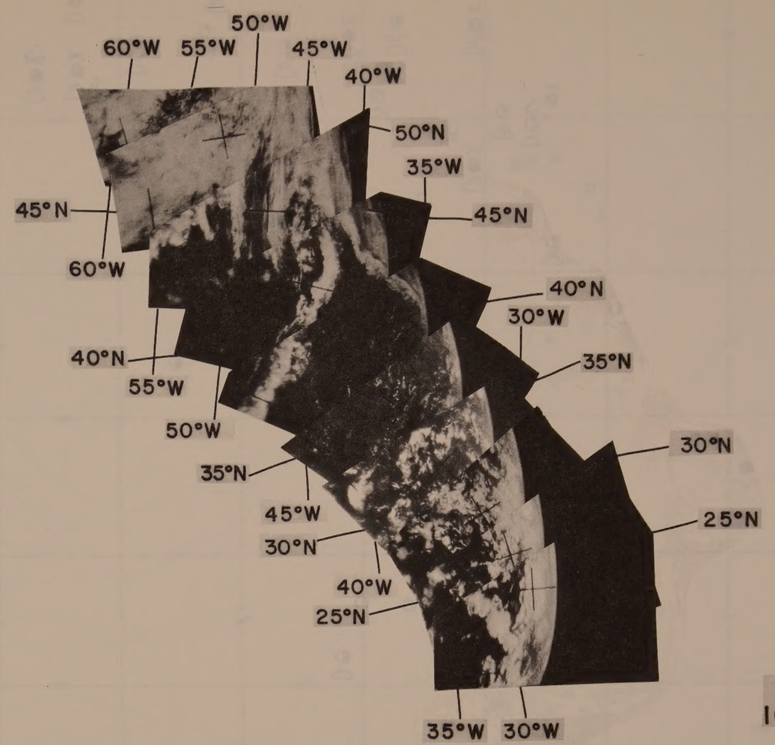
There is no way to comment briefly on the relationships between satellite and conventional charts which cover an entire month and a very large area. We have chosen, therefore, as stated earlier, to leave all such comments to the Part III section entitled "Special Topics".


L
H
L
L
12
16
20
24
28
08
SURFACE
1 SEPT. 1963
1200 GMT


ISOBARS
1 SEPT 1963
SURFACE
10
50
H
L



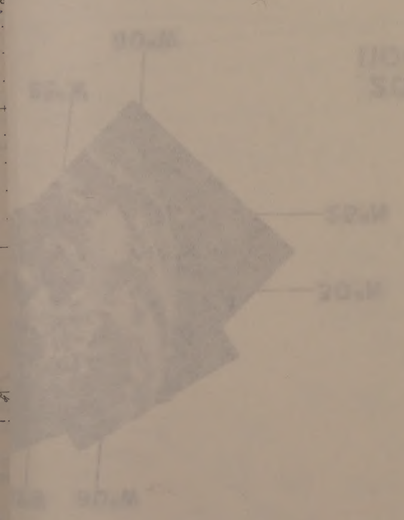
2015Z
1100 DIR

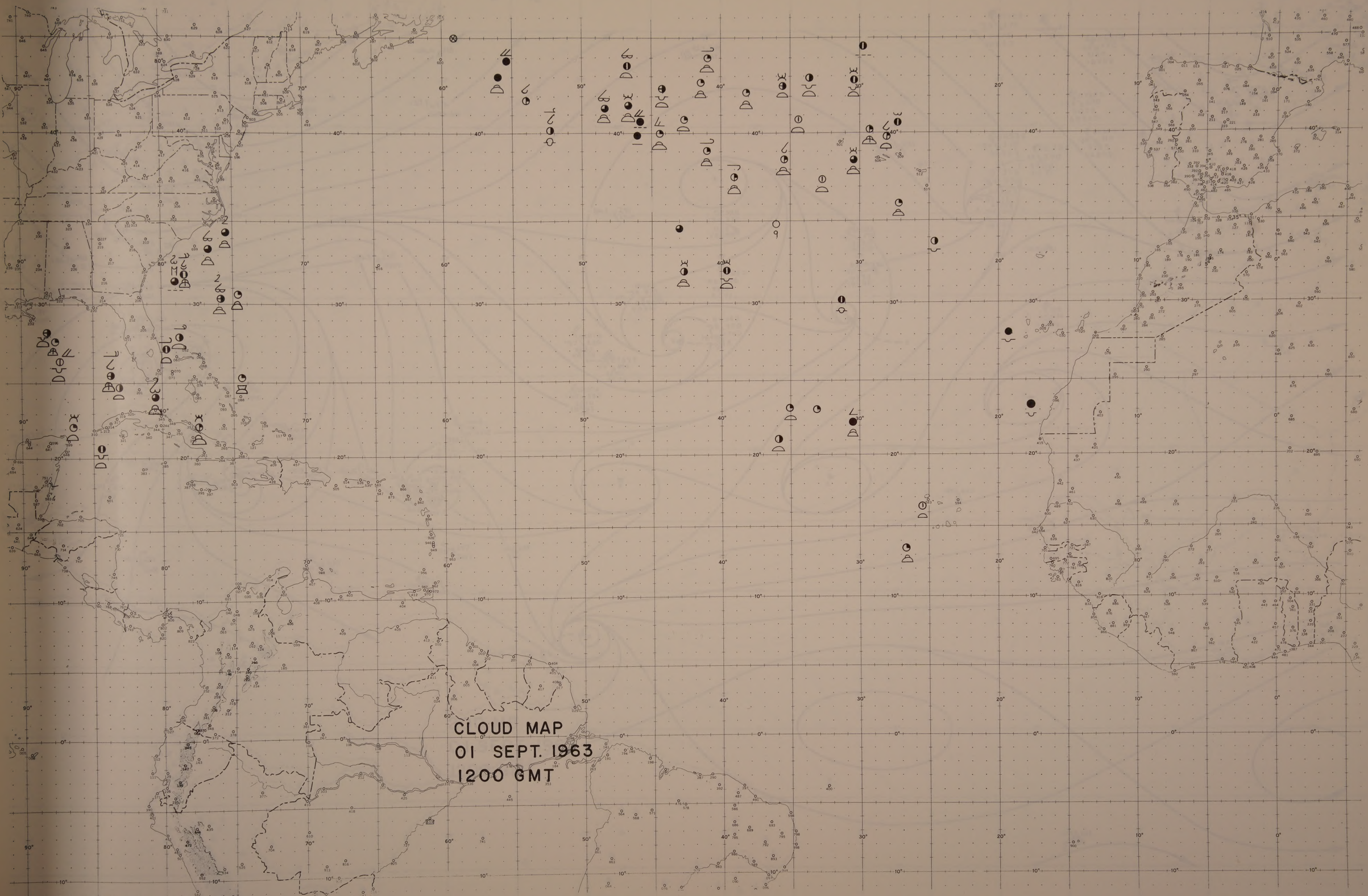


1655Z
1099/1098

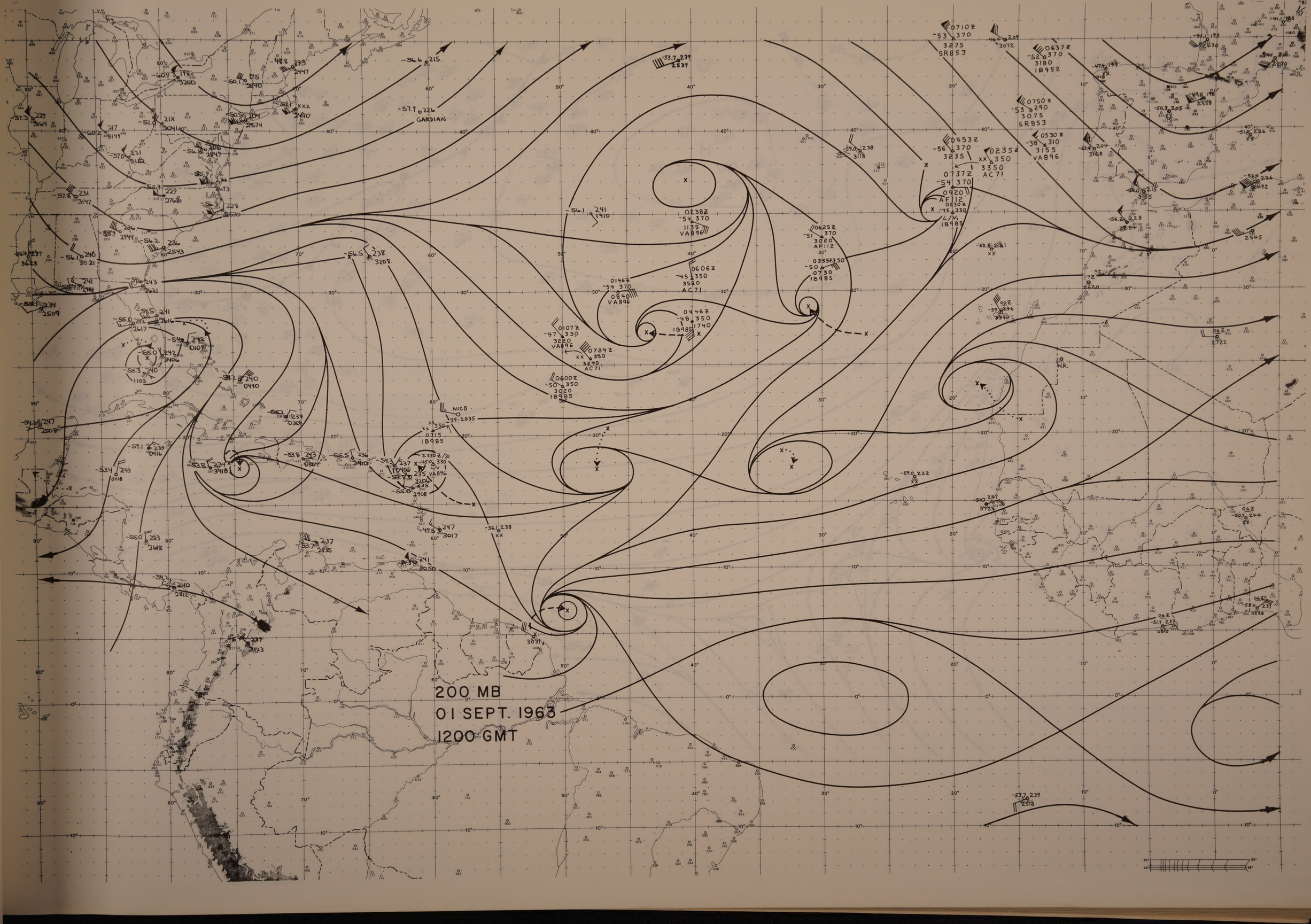
CLOUD MAP
01 SEPT 1963
1200 GMT

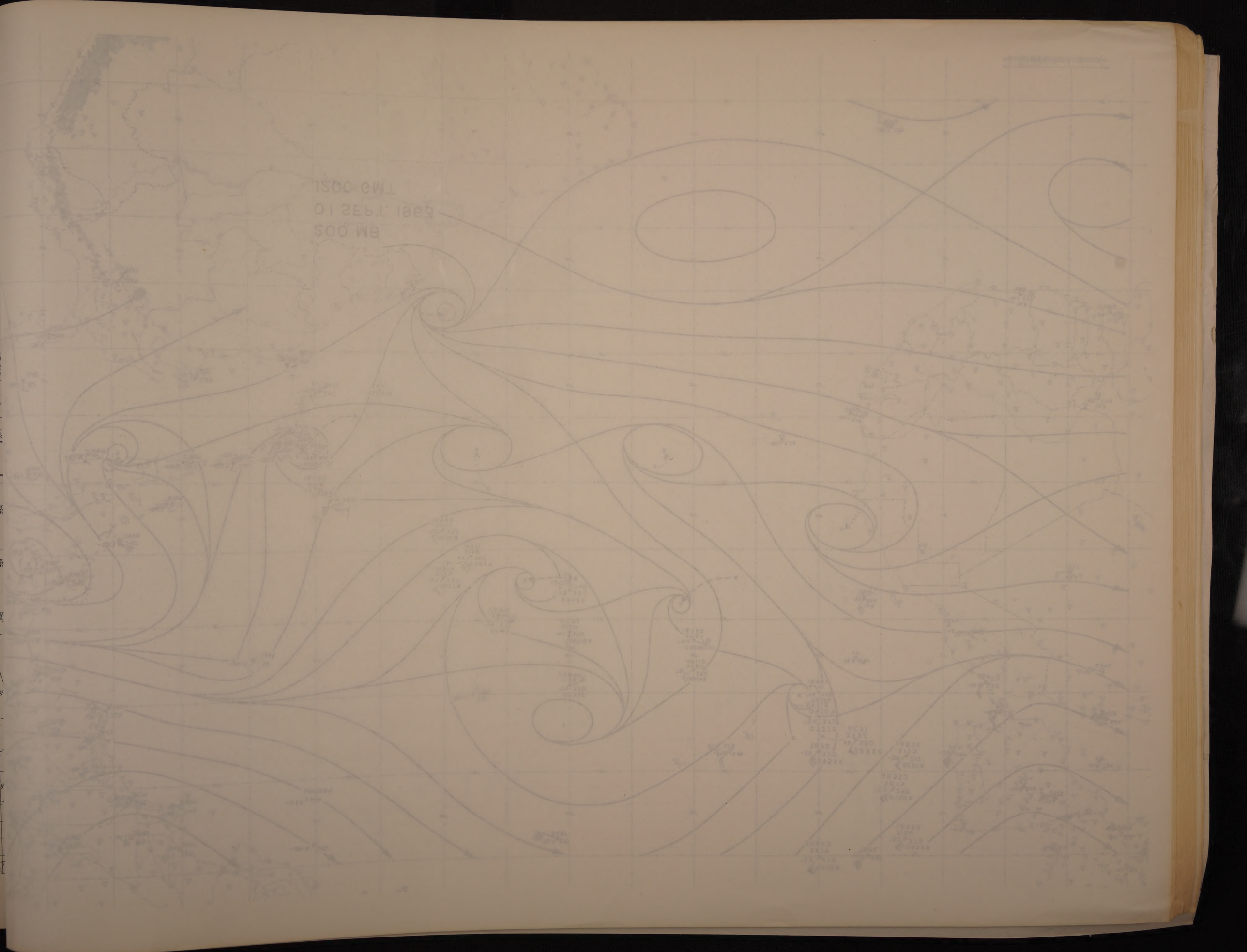
1 SEPTEMBER 1963



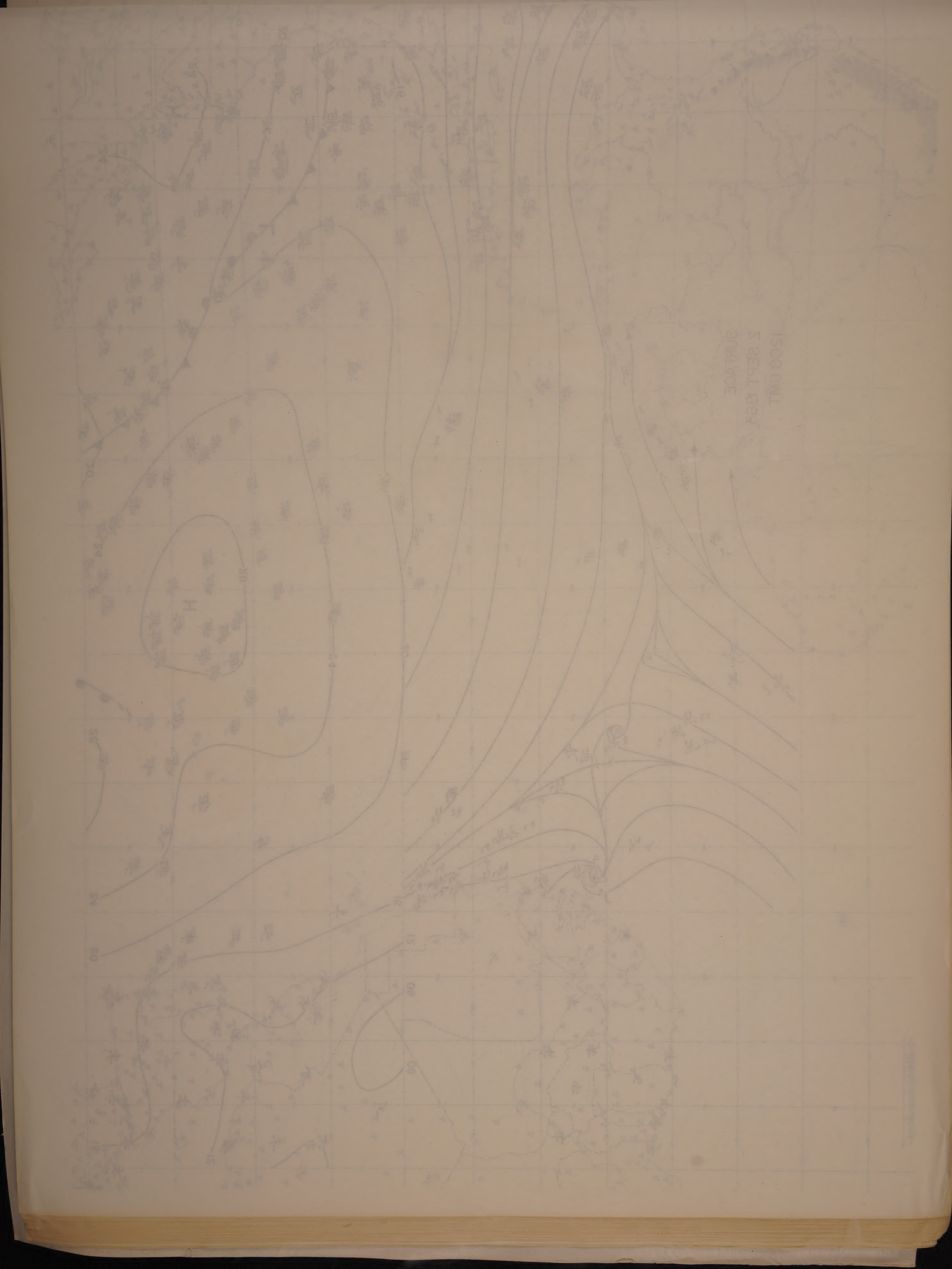

CLOUD MAP
01 SEPT. 1963
1200 GMT

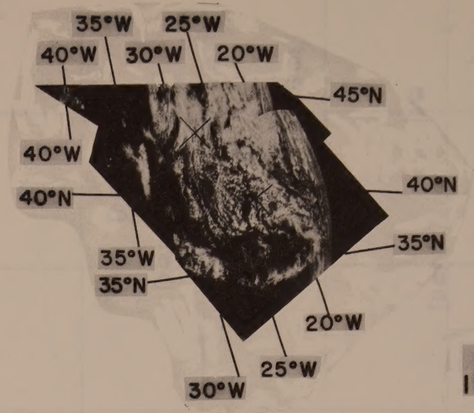
CLOUD MAP
01 SEPT 1963
1200 GMT


200 MB
01 SEPT. 1963
1200 GMT

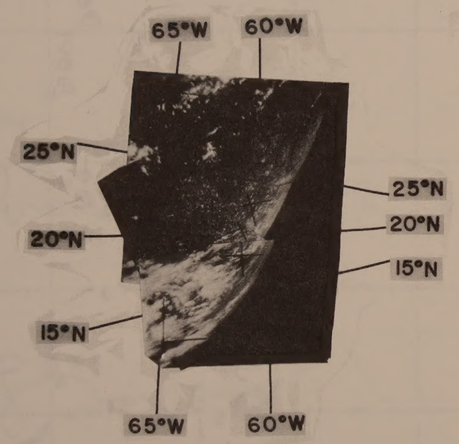


SURFACE
2 SEPT. 1963
1200 GMT


ISOBARS
SOURCE
SINK



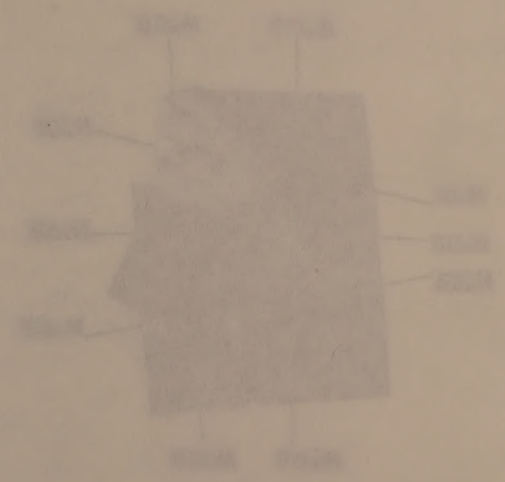
1533Z
1113/1112

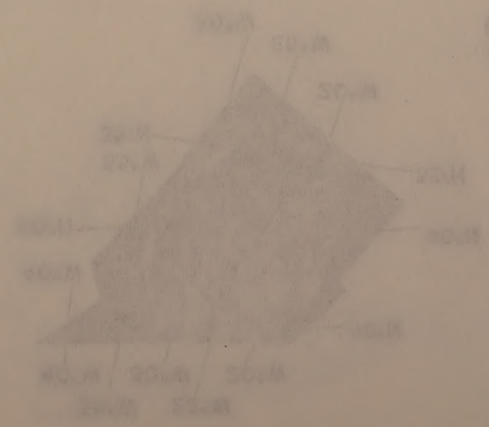


1901Z
1114 DIR

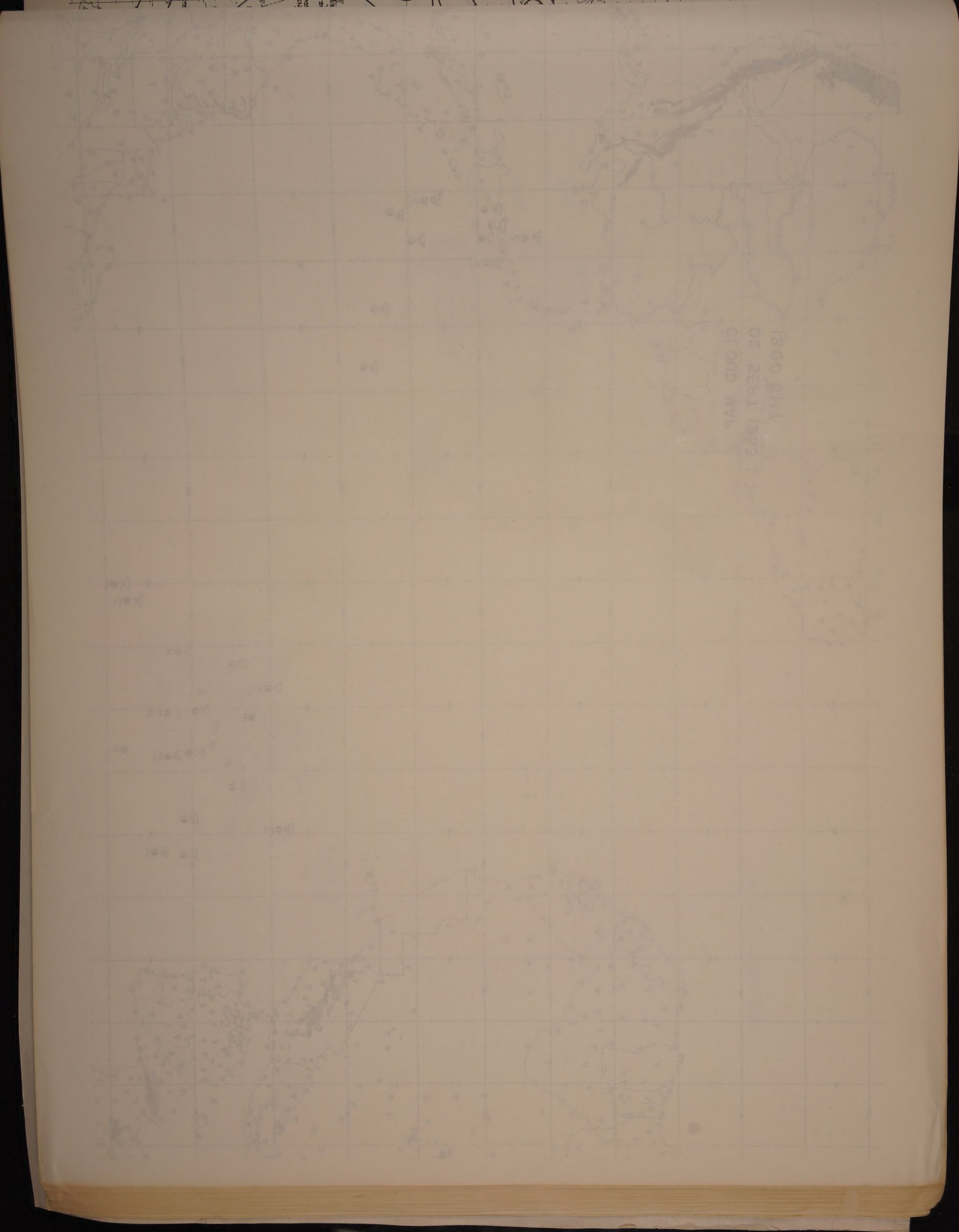
CLOUD MAP
02 SEPT 1963
1200 GMT

2 SEPTEMBER 1963



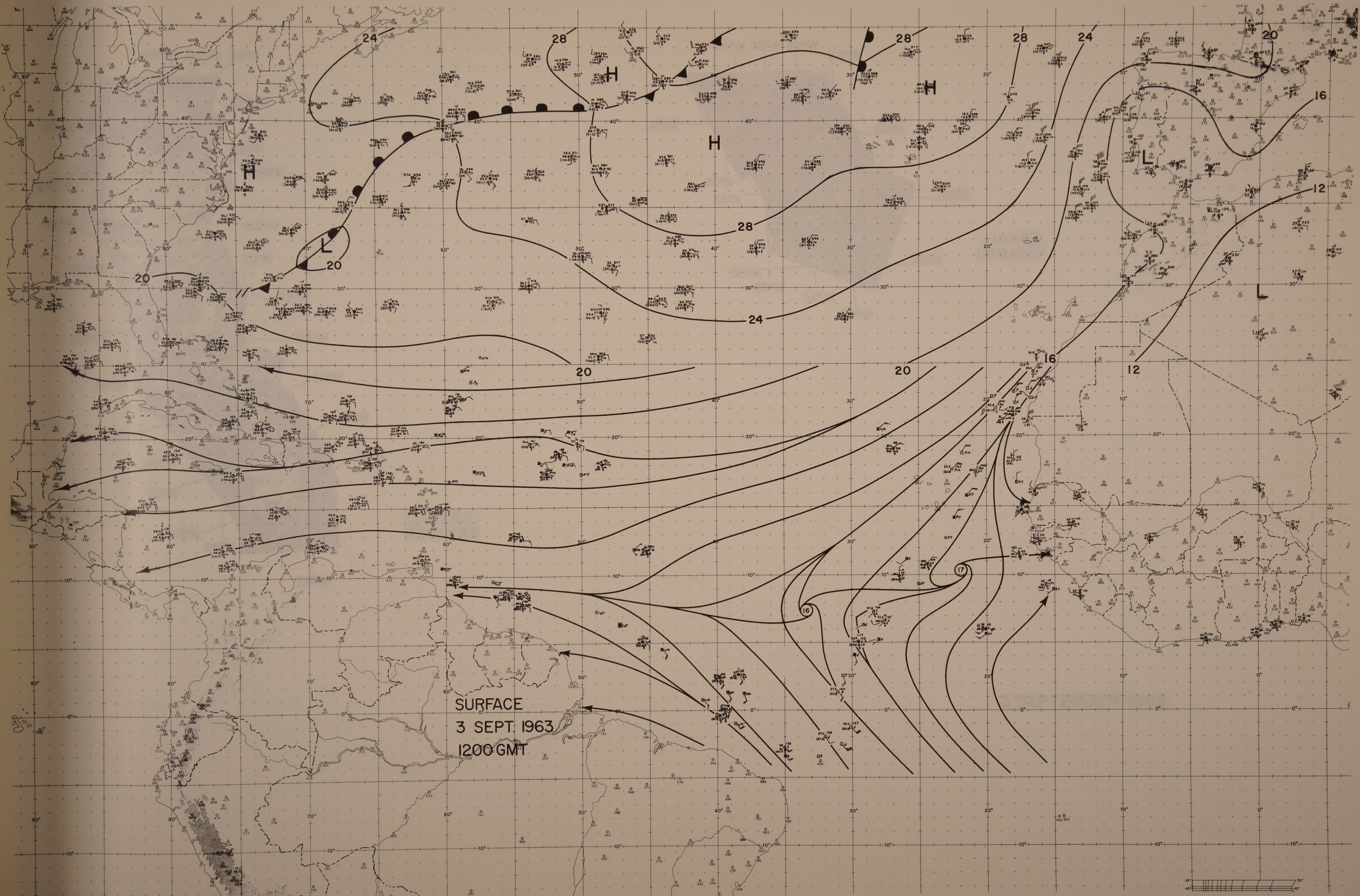


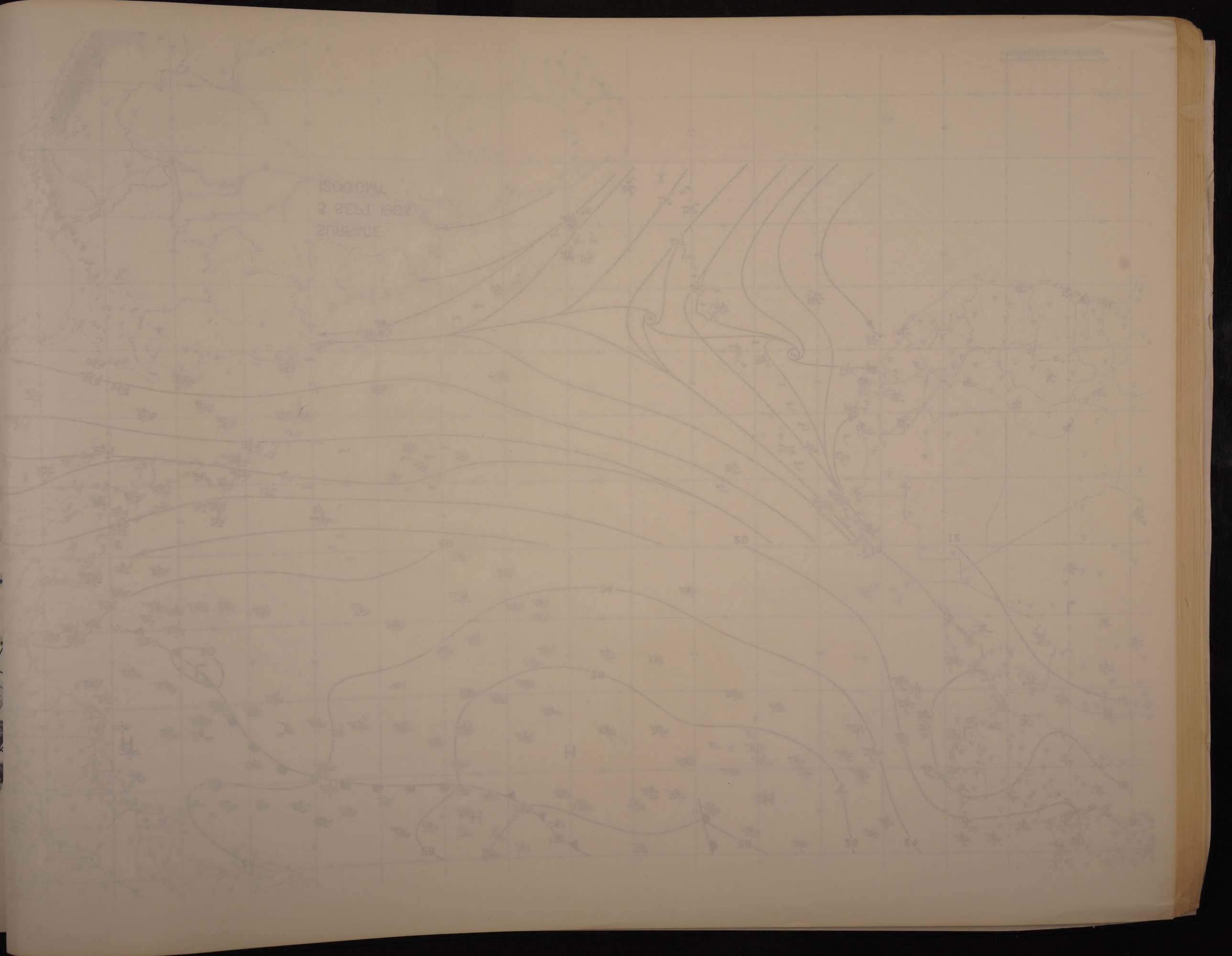
CLOUD MAP
02 SEPT. 1963
1200 GMT

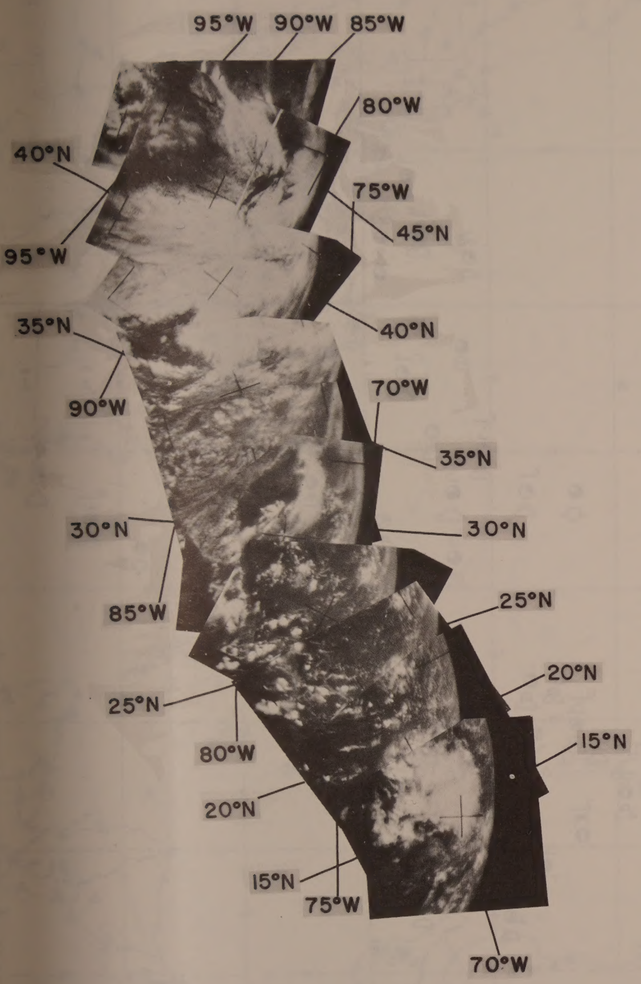


200 MB
02 SEPT. 1963
1200 GMT

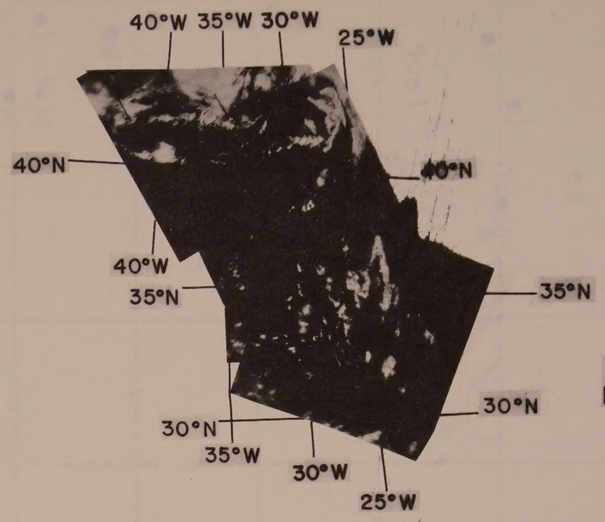
200 MB
02 SEPT 1963
1200 GMT


H
H
H
H
L
L
L
L
28
28
28
28
24
24
24
20
20
20
20
16
16
16
12
12
17
SURFACE
3 SEPT. 1963
1200 GMT



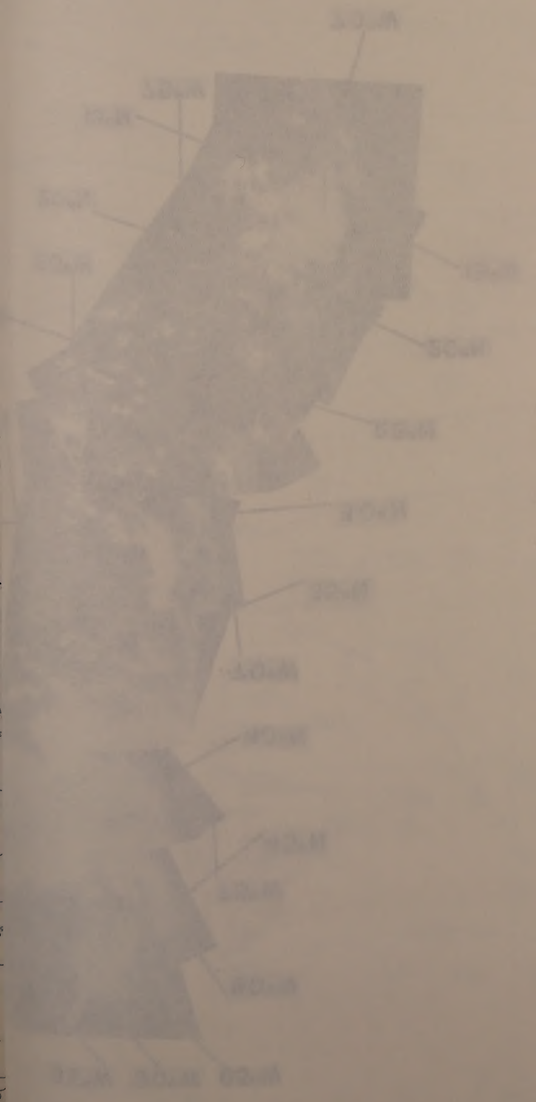


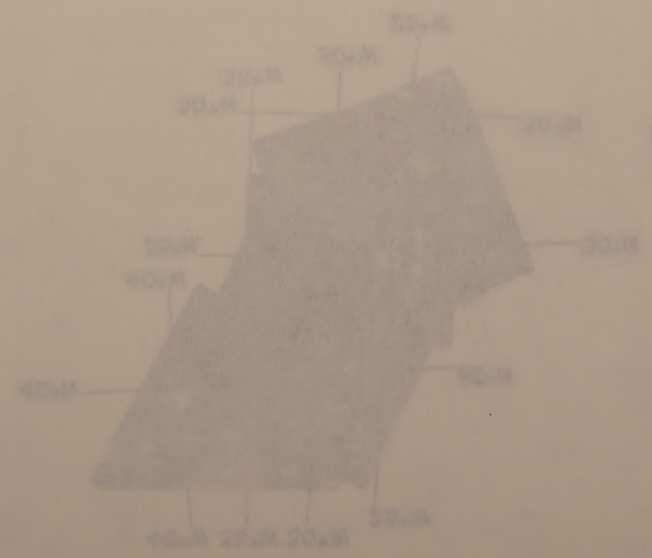
1917Z
1130/1129



1556Z
1128/1127

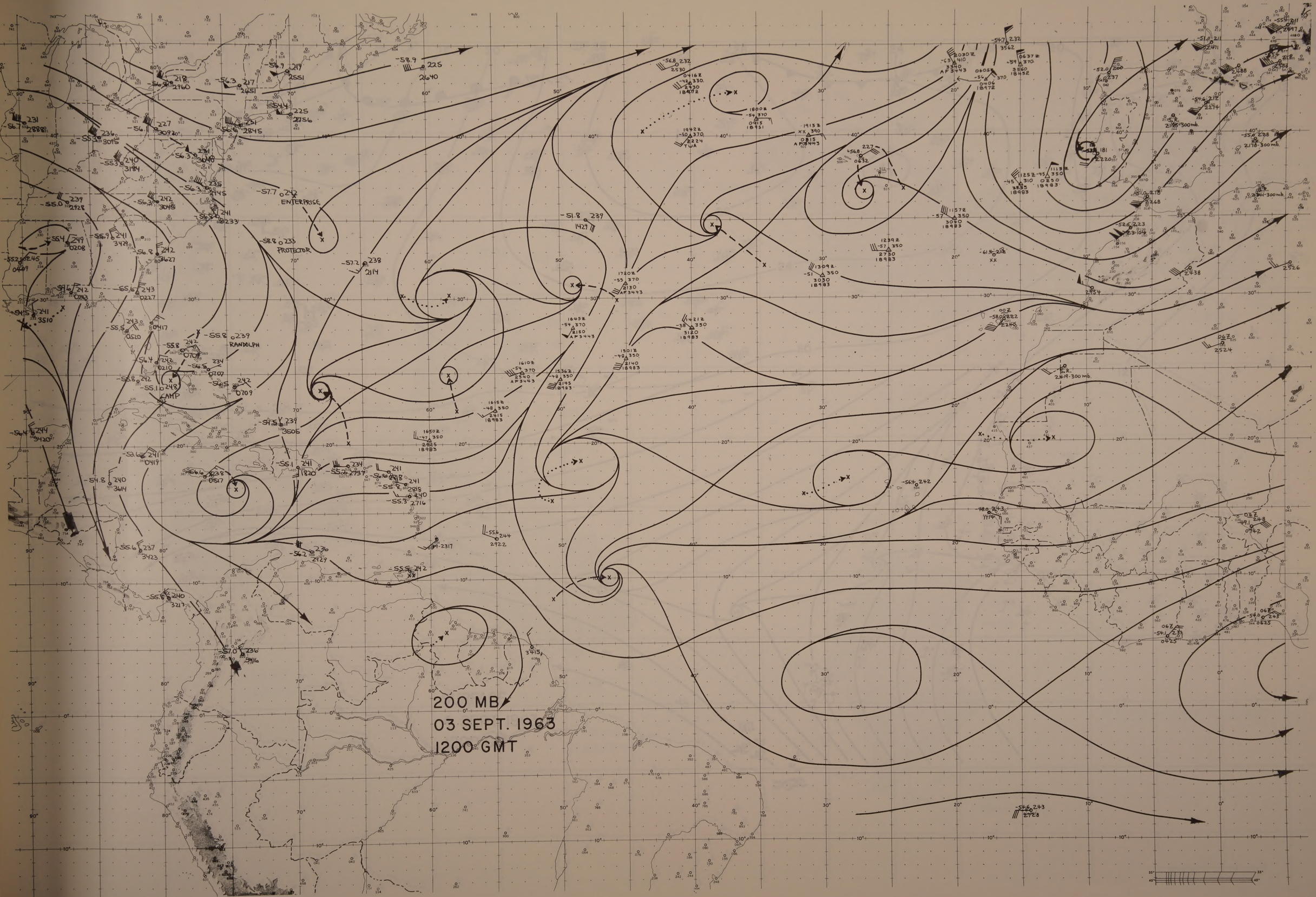
3 SEPTEMBER 1963

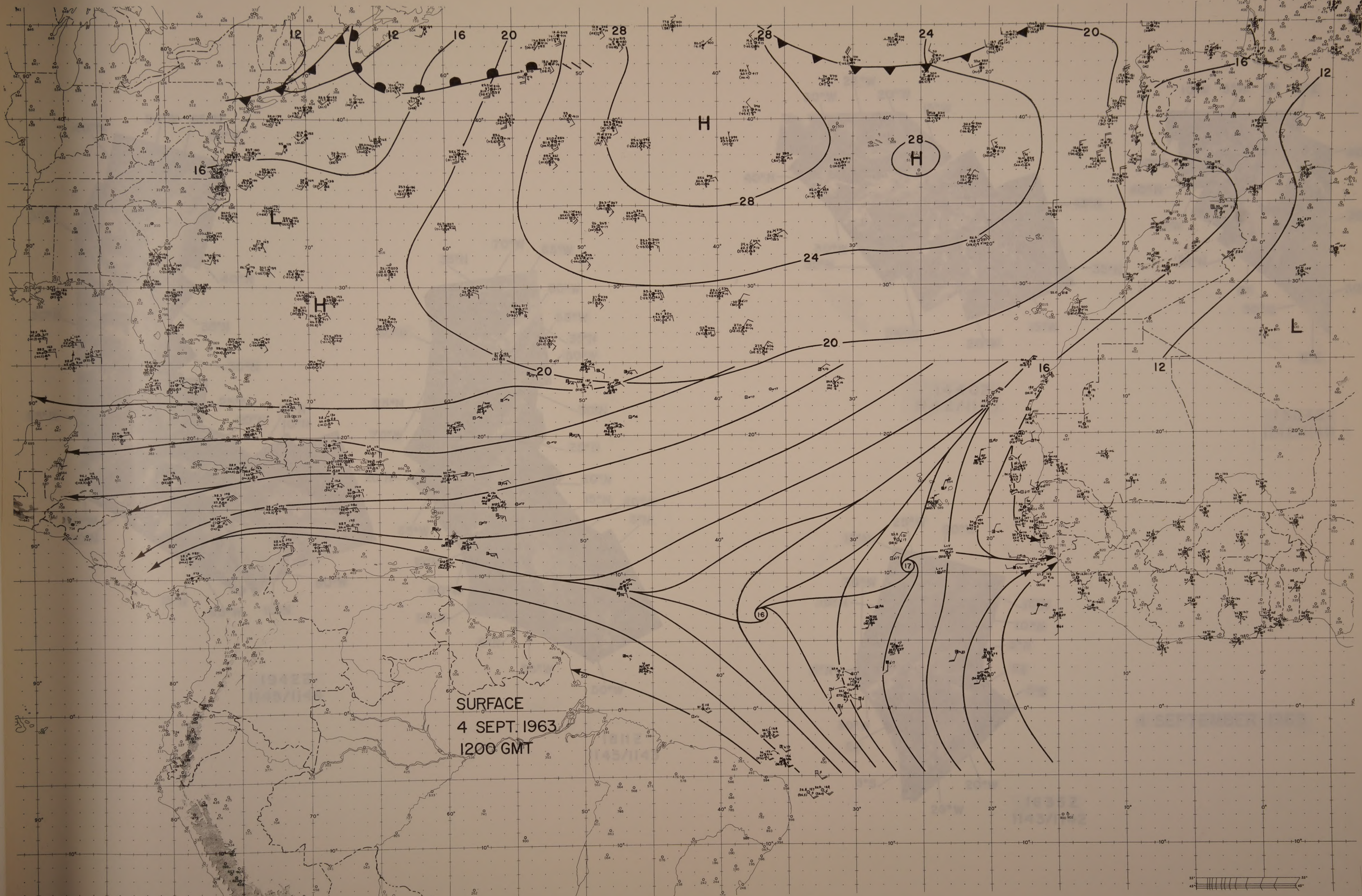


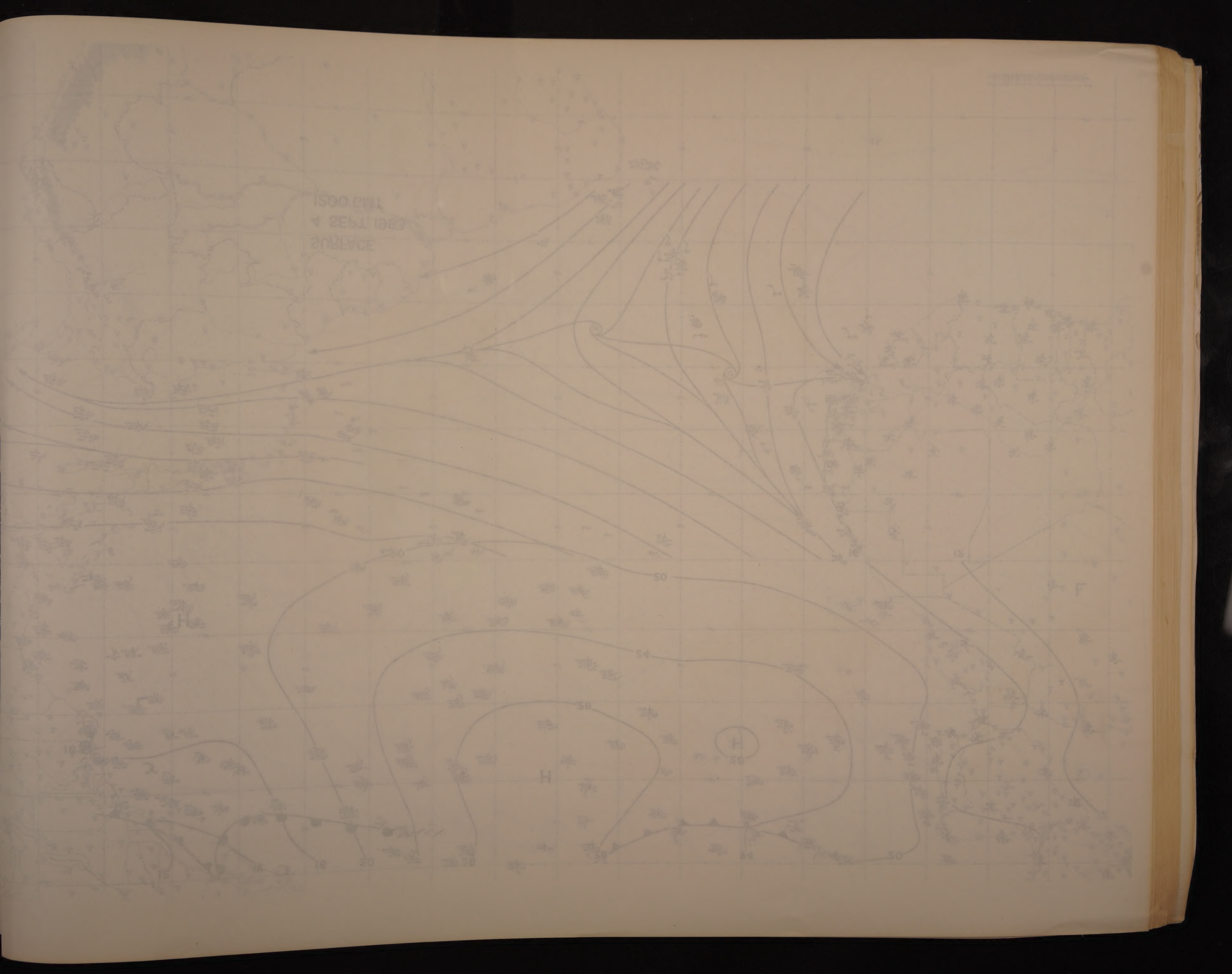


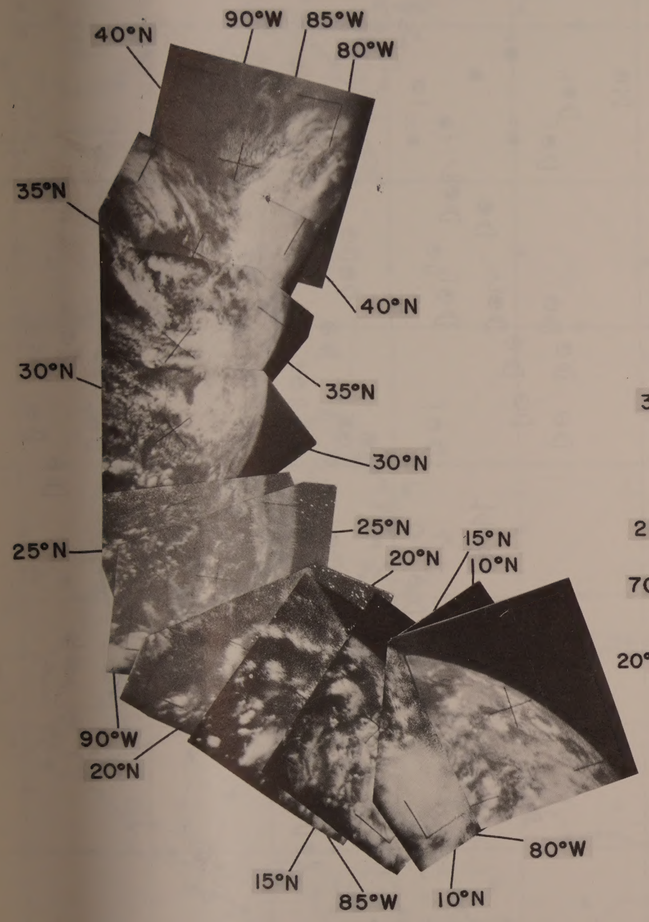
CLOUD MAP
03 SEPT. 1963
1200 GMT

1500 GMT
03 SEPT 1963
CLOUD MAP

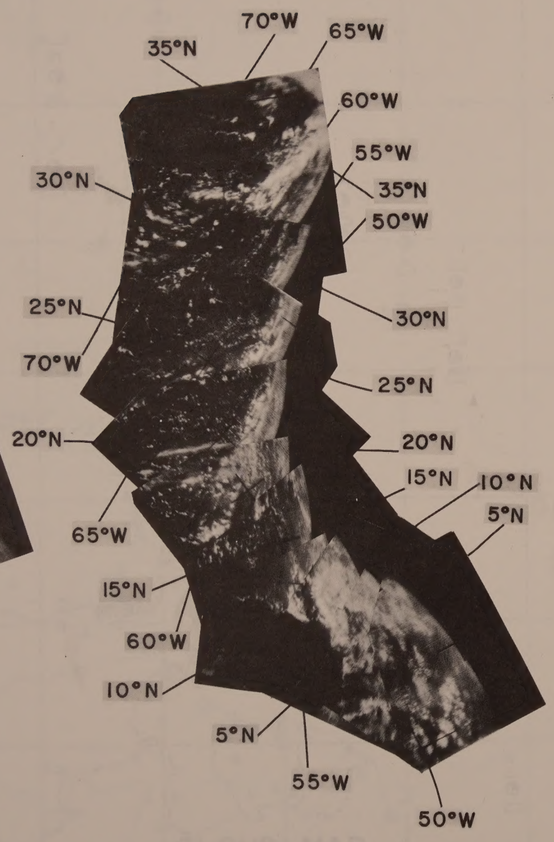

ENTERPRISE
PROTECTOR
RANDOLPH
CAMP
200 MB
03 SEPT. 1963
1200 GMT


12
12
16
20
28
28
24
20
16
12
16
H
28
H
28
24
L
H
L
20
20
16
12
17
16
SURFACE
4 SEPT. 1963
1200 GMT

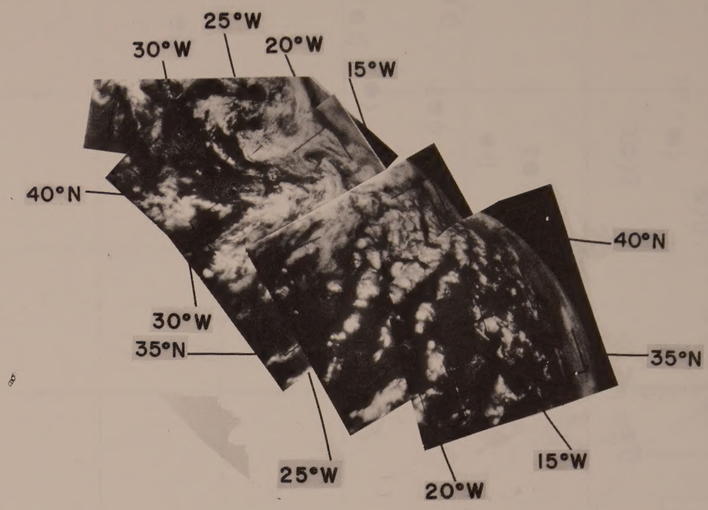

H
H
H
50
54
58
50
50
50



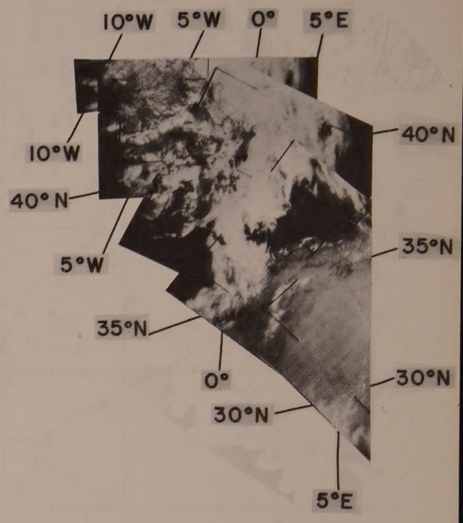
1942Z
1145/1144



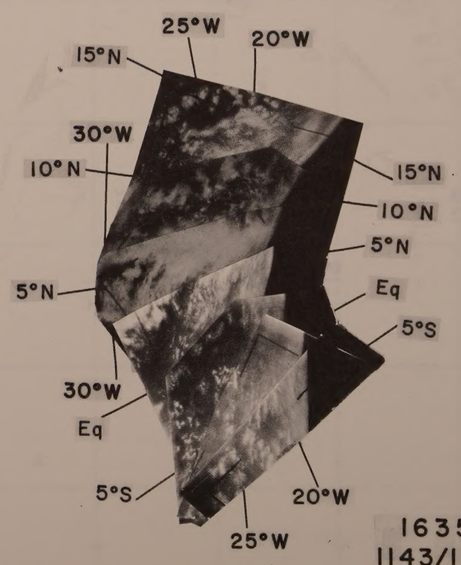
1811Z
1145/1143



1440Z
1142/1141

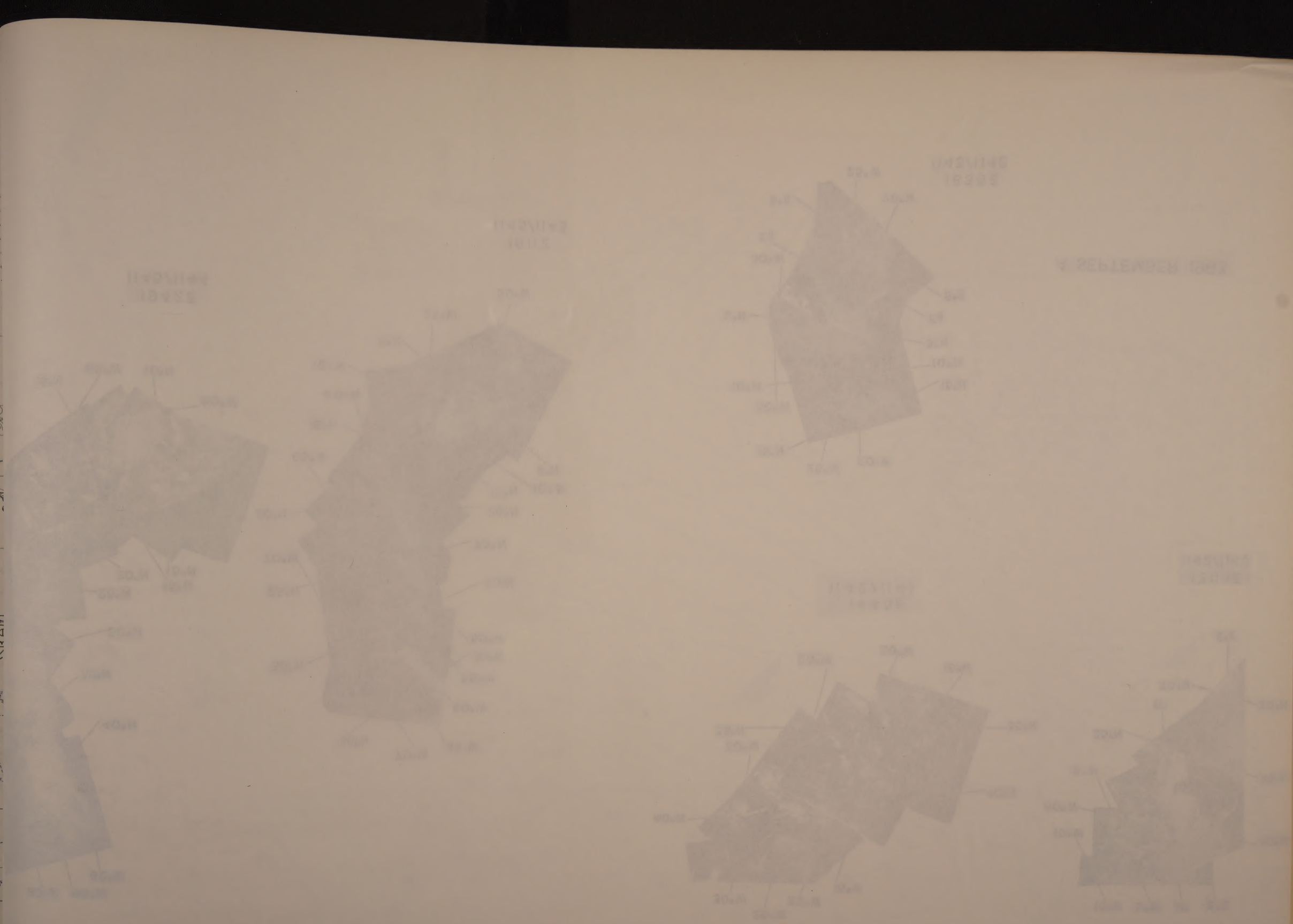


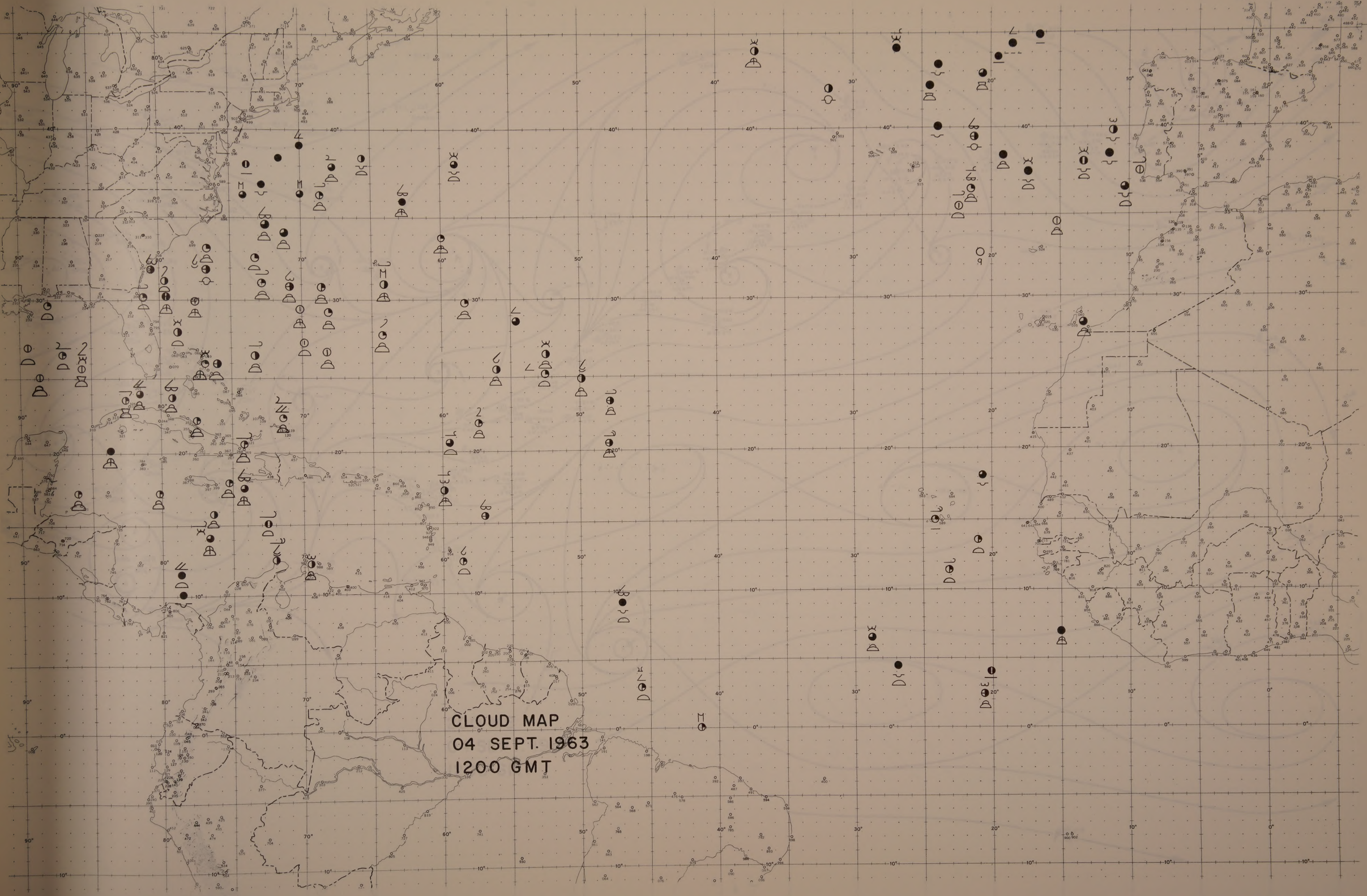
1304Z
1142/1140

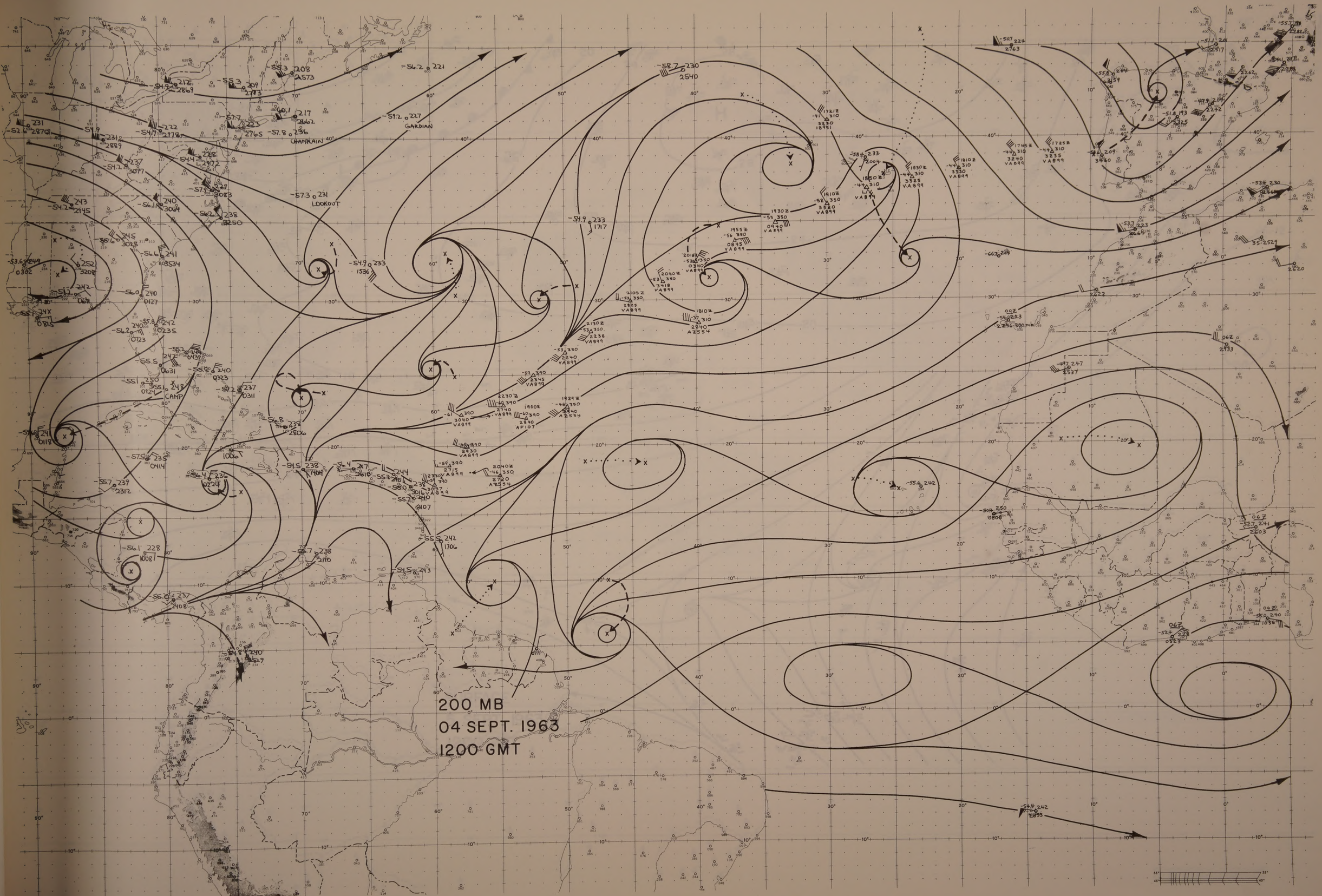


1635Z
1143/1142

4 SEPTEMBER 1963



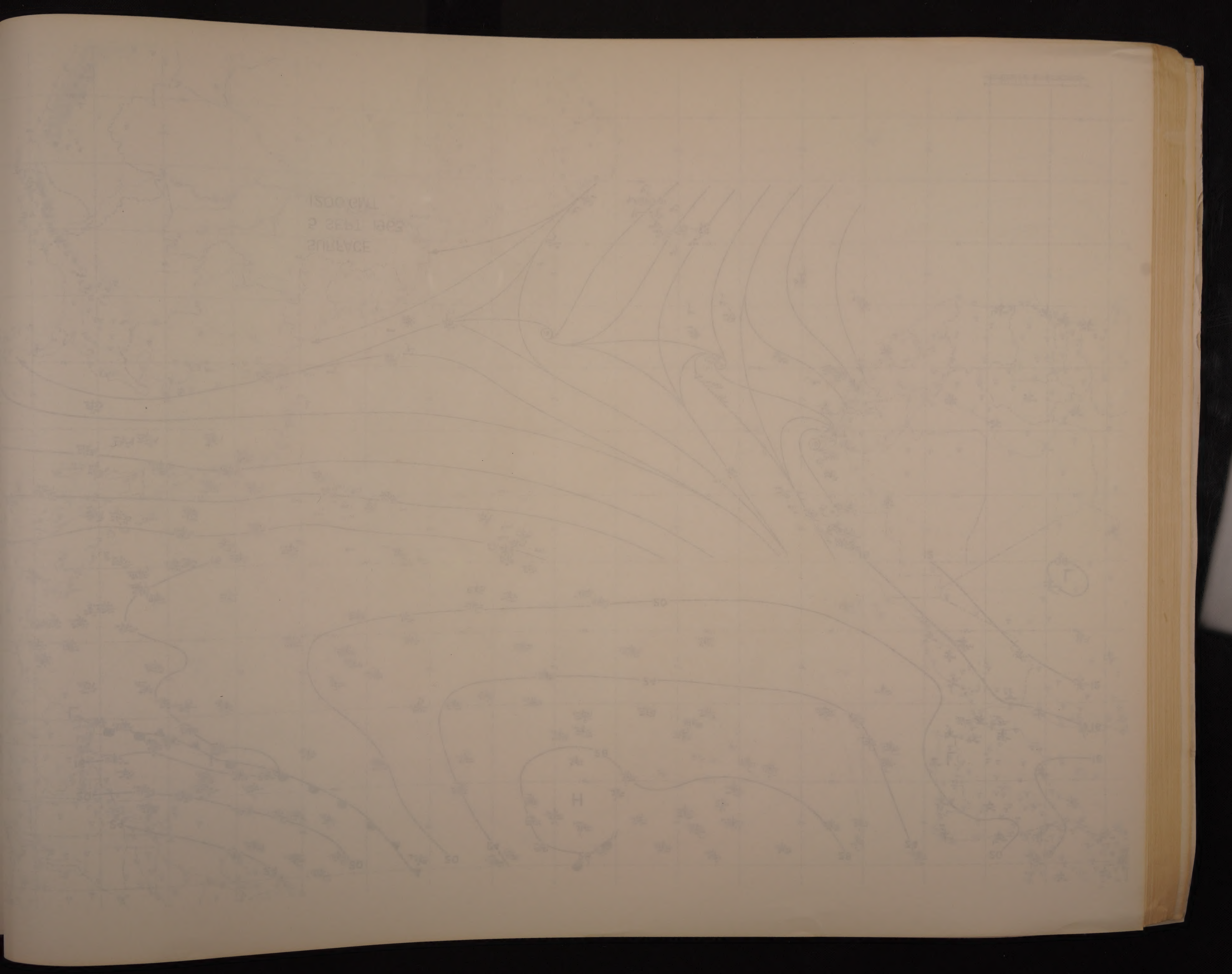

CLOUD MAP
04 SEPT. 1963
1200 GMT

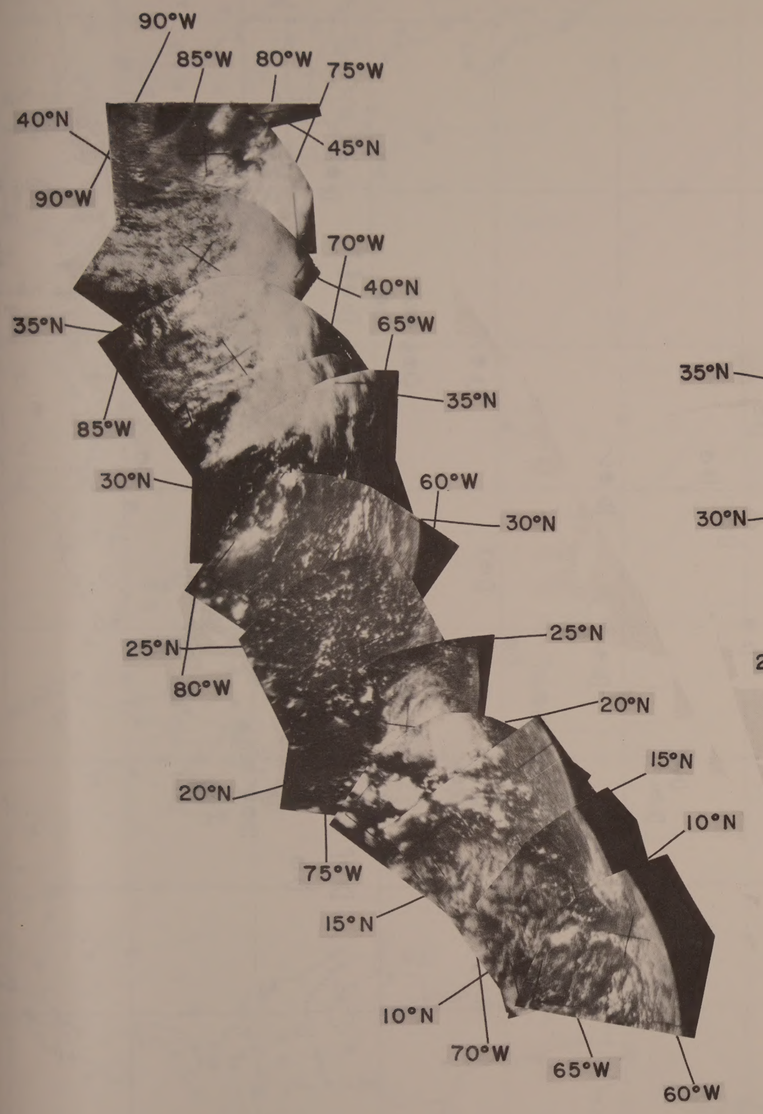

200 MB
04 SEPT. 1963
1200 GMT

SURFACE

5 SEPT. 1963

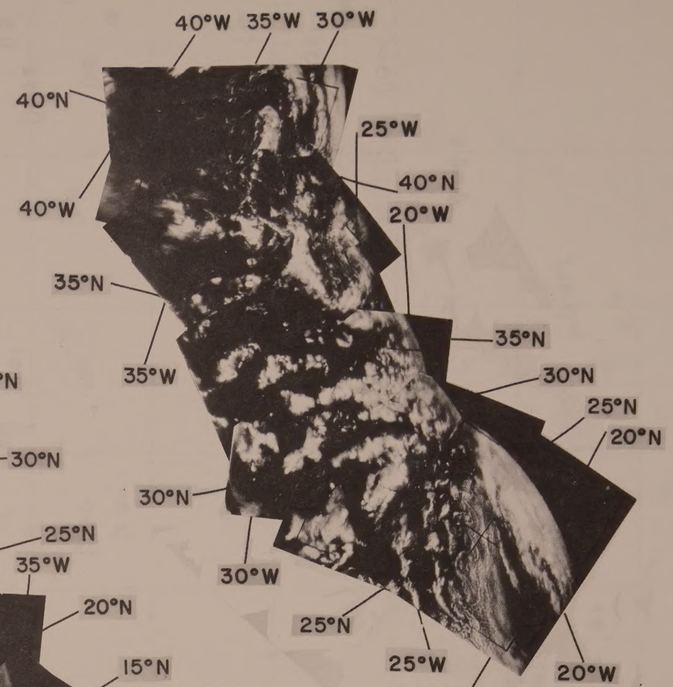
1200 GMT


H



1826Z
1159/1158

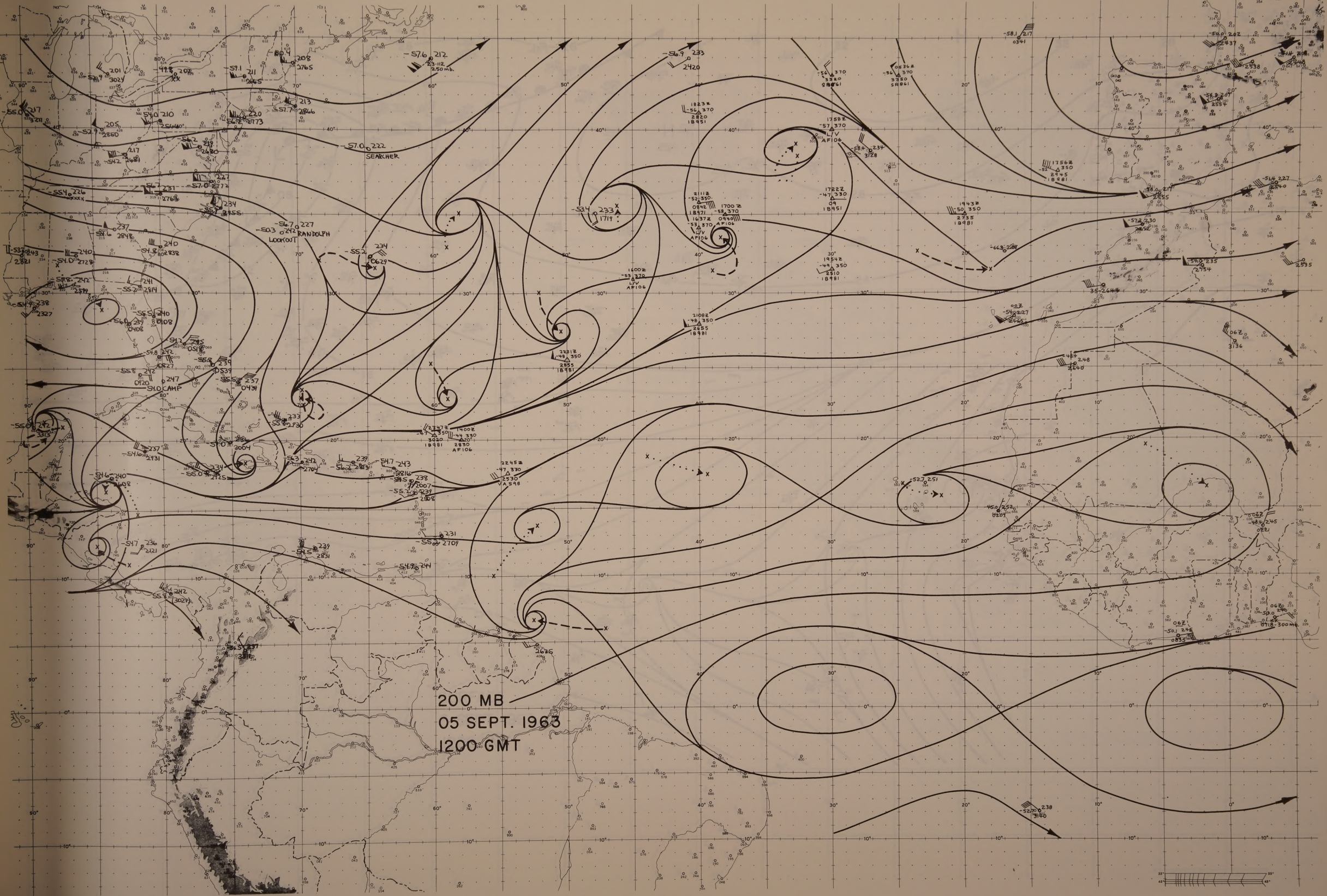
1653Z
1159/1157

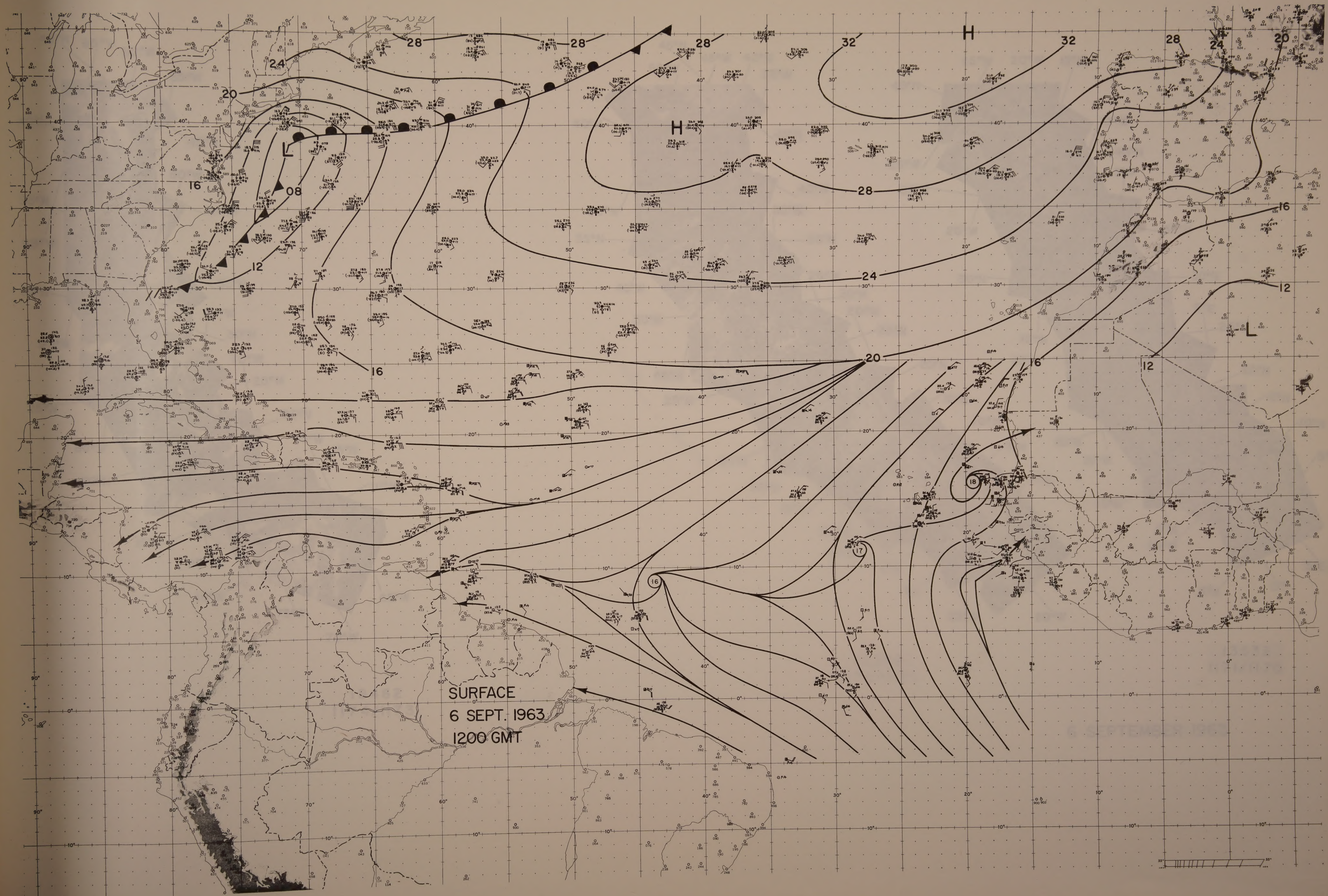


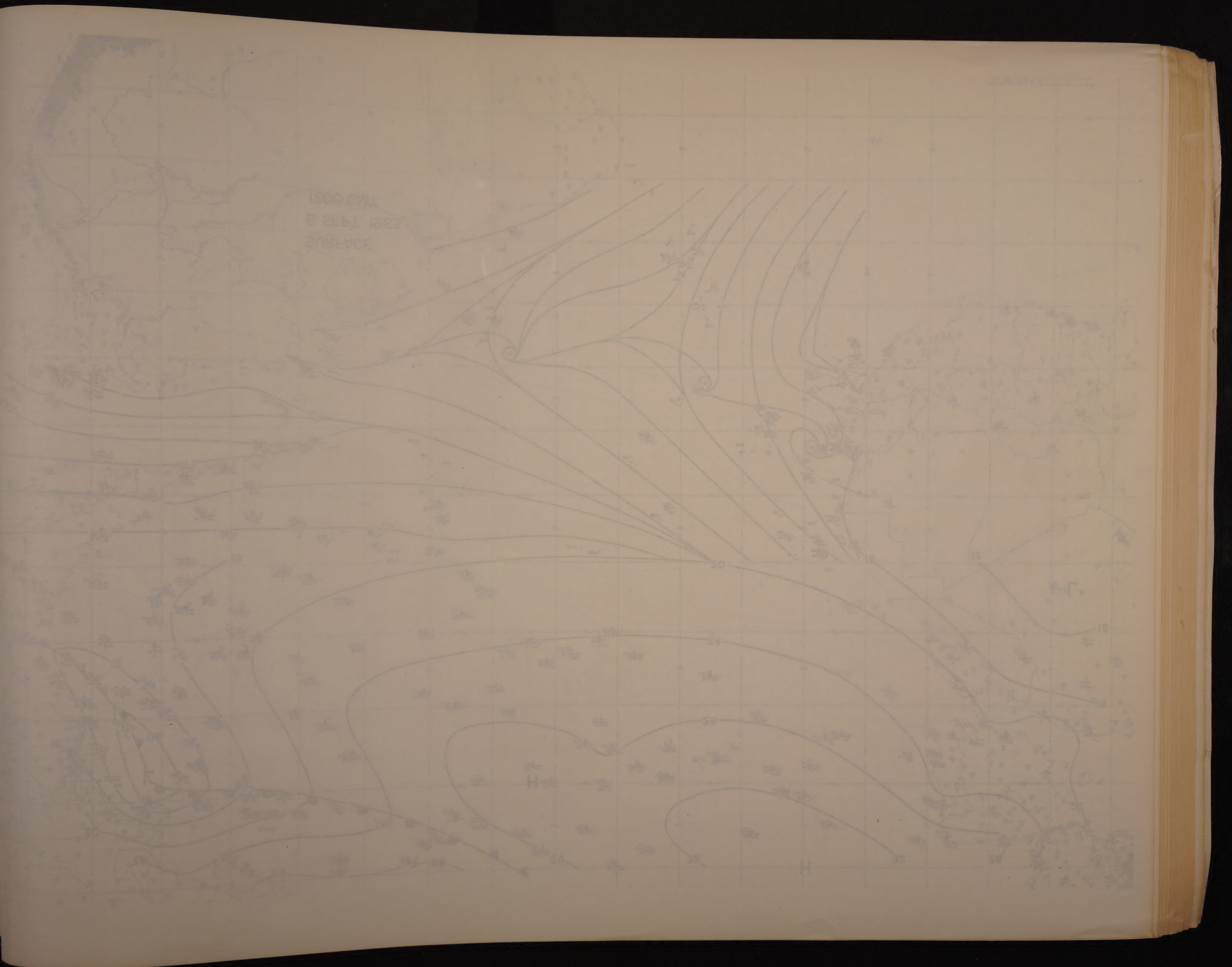
1505Z
1157/1156

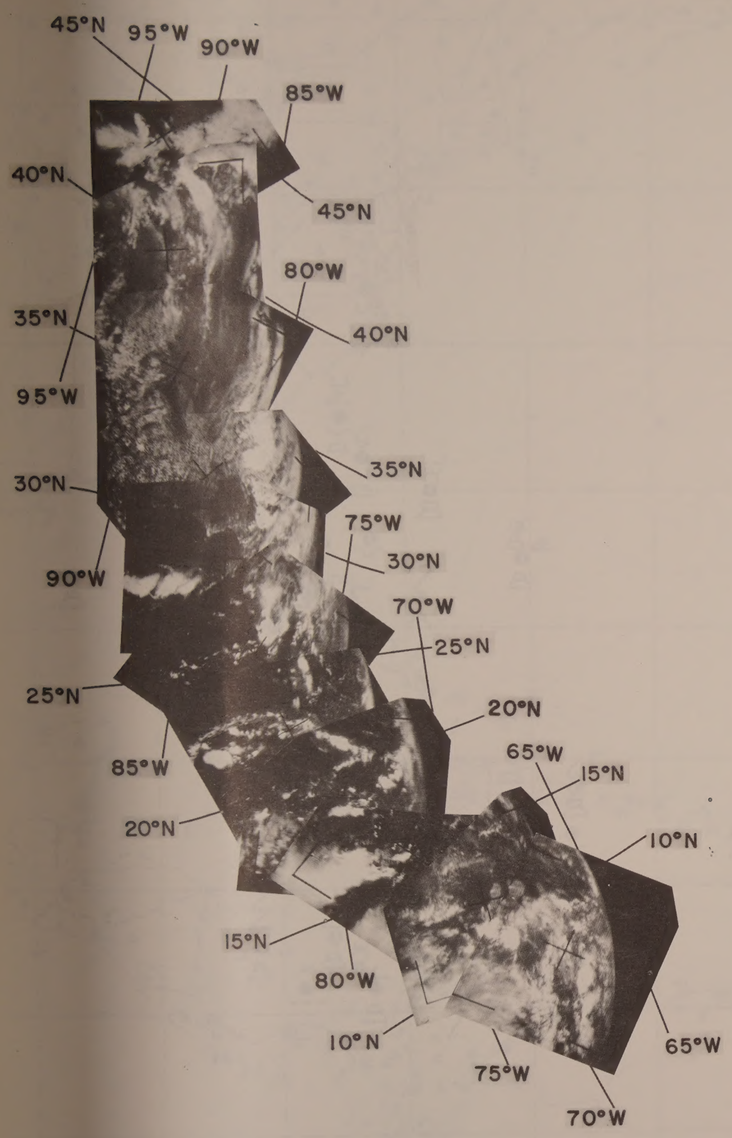
5 SEPTEMBER 1963

CLOUD MAP
05 SEPT. 1963
1200 GMT


SEARCHER
RANDOLPH
LOOKOUT
SHOCAMP
200 MB
05 SEPT. 1963
1200 GMT


H
H
L
L
28
24
20
16
12
08
32
28
24
20
16
12
SURFACE
6 SEPT. 1963
1200 GMT



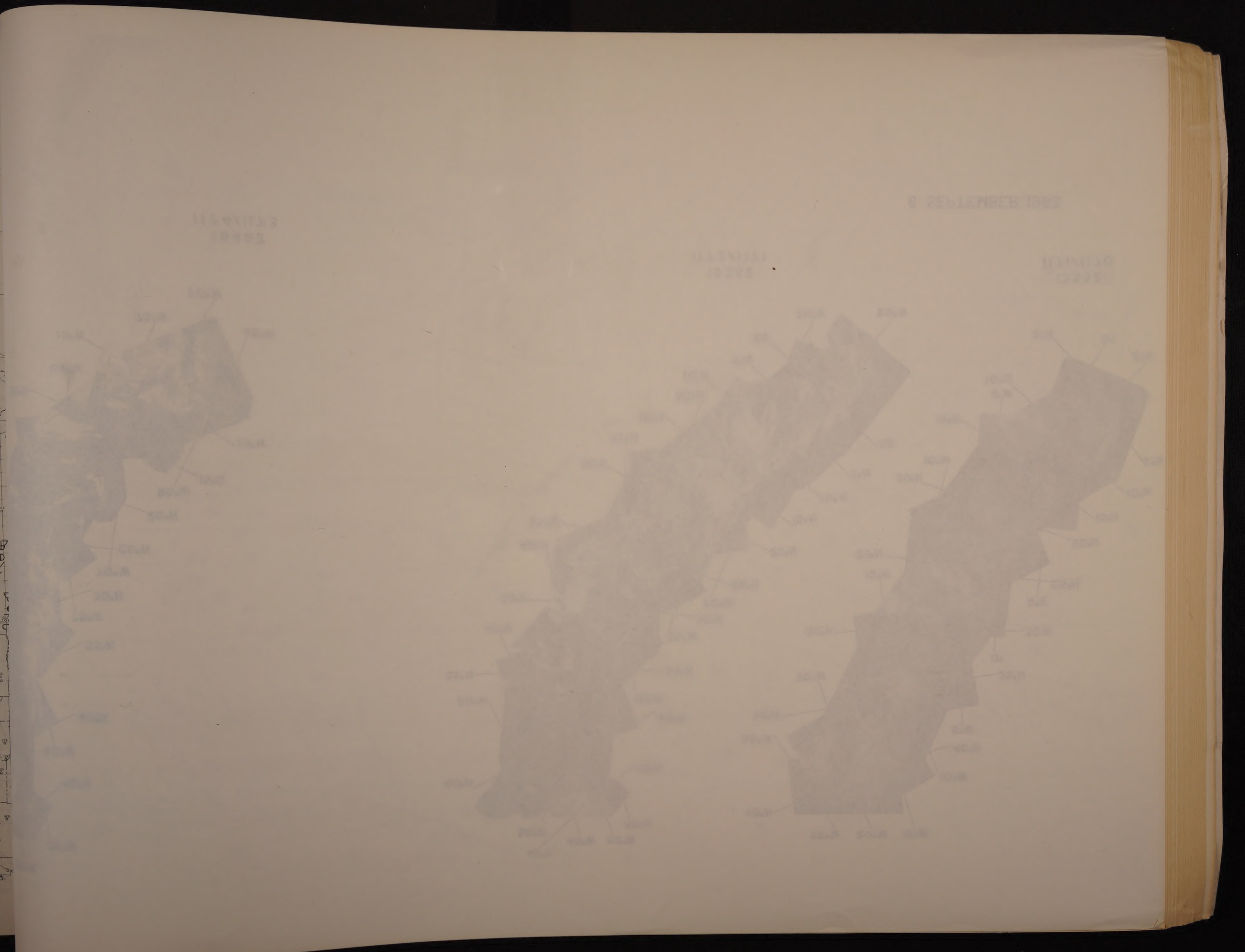


1846Z
1174/1173

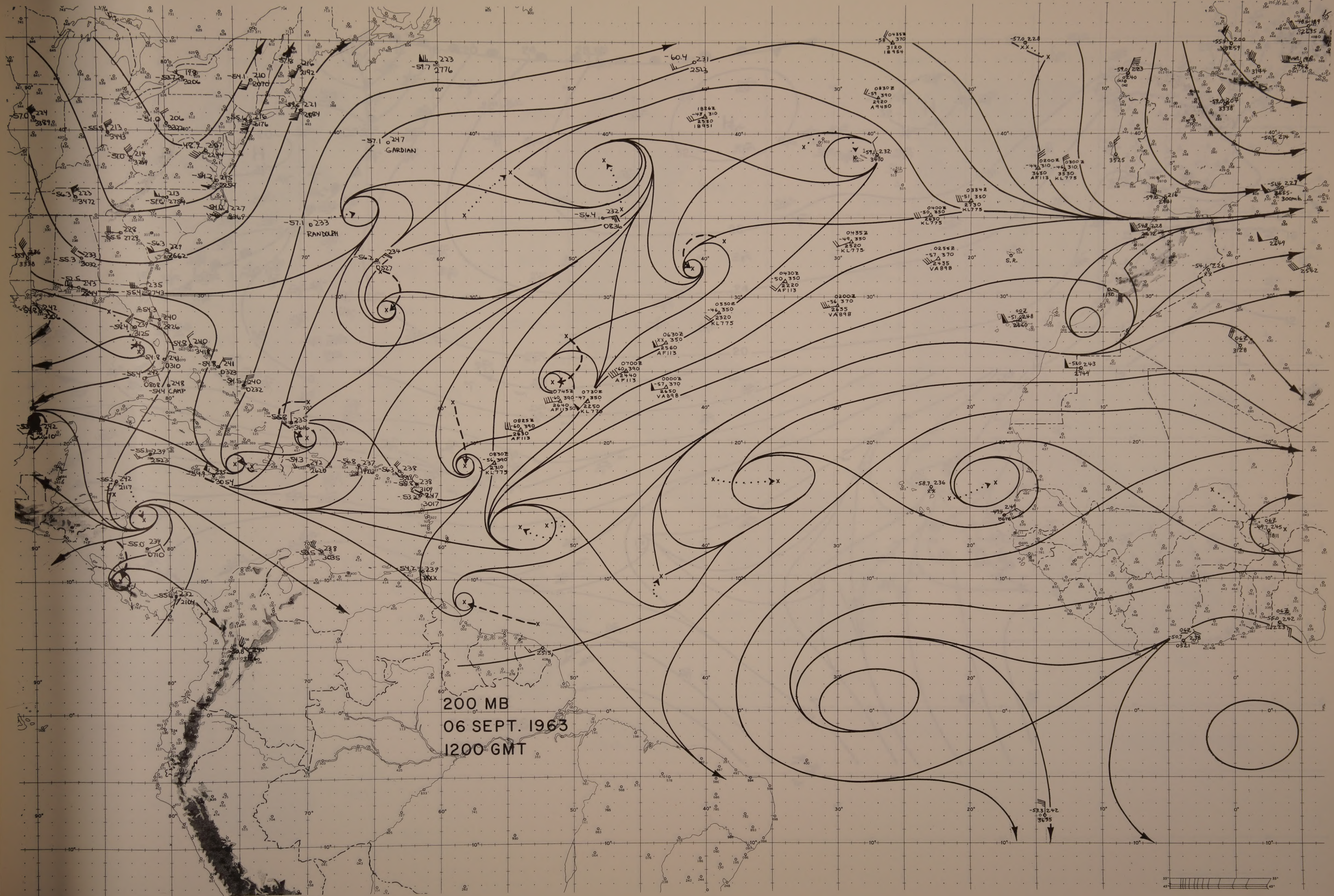
1535Z
1172/1171

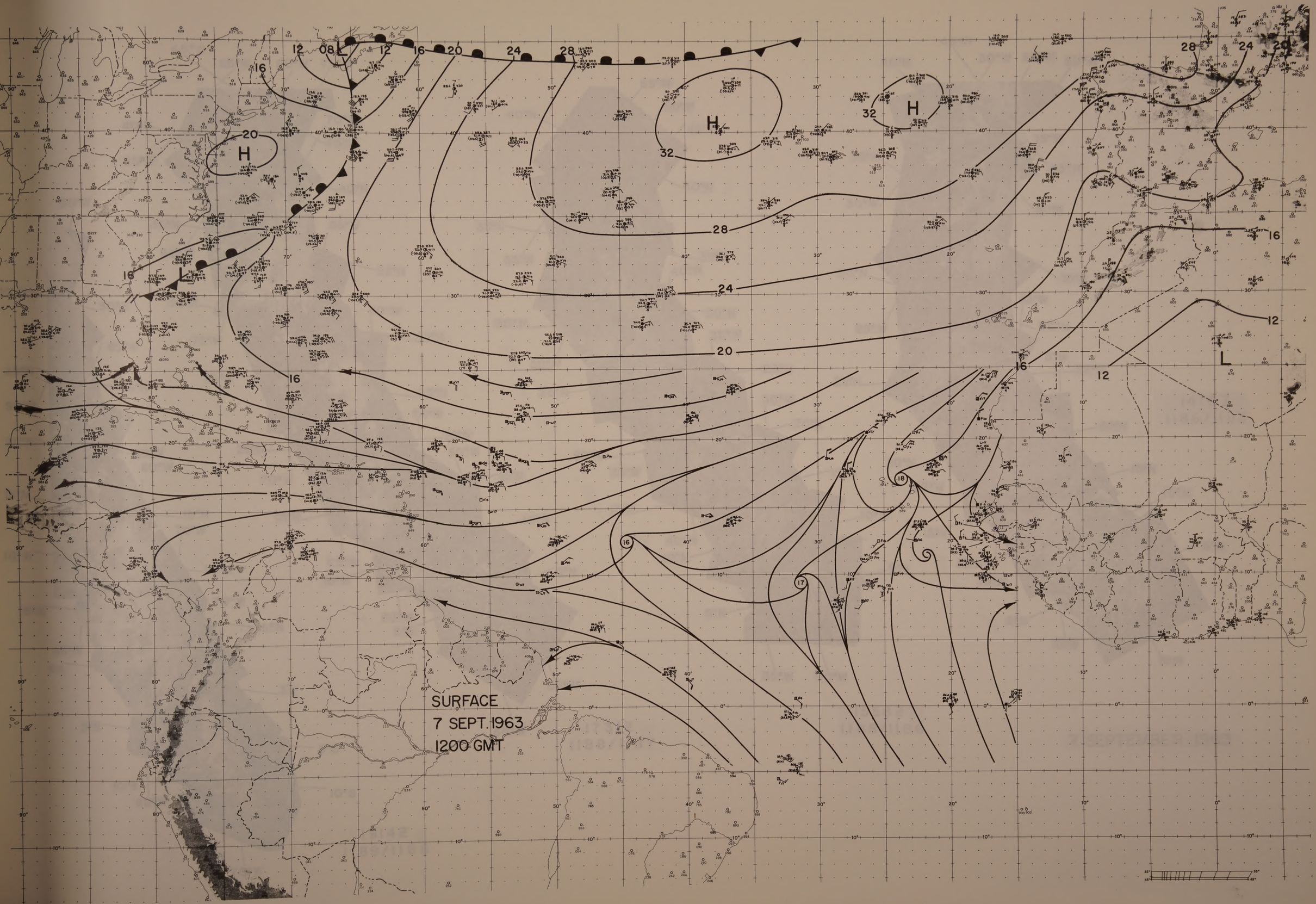
1353Z
1171/1170

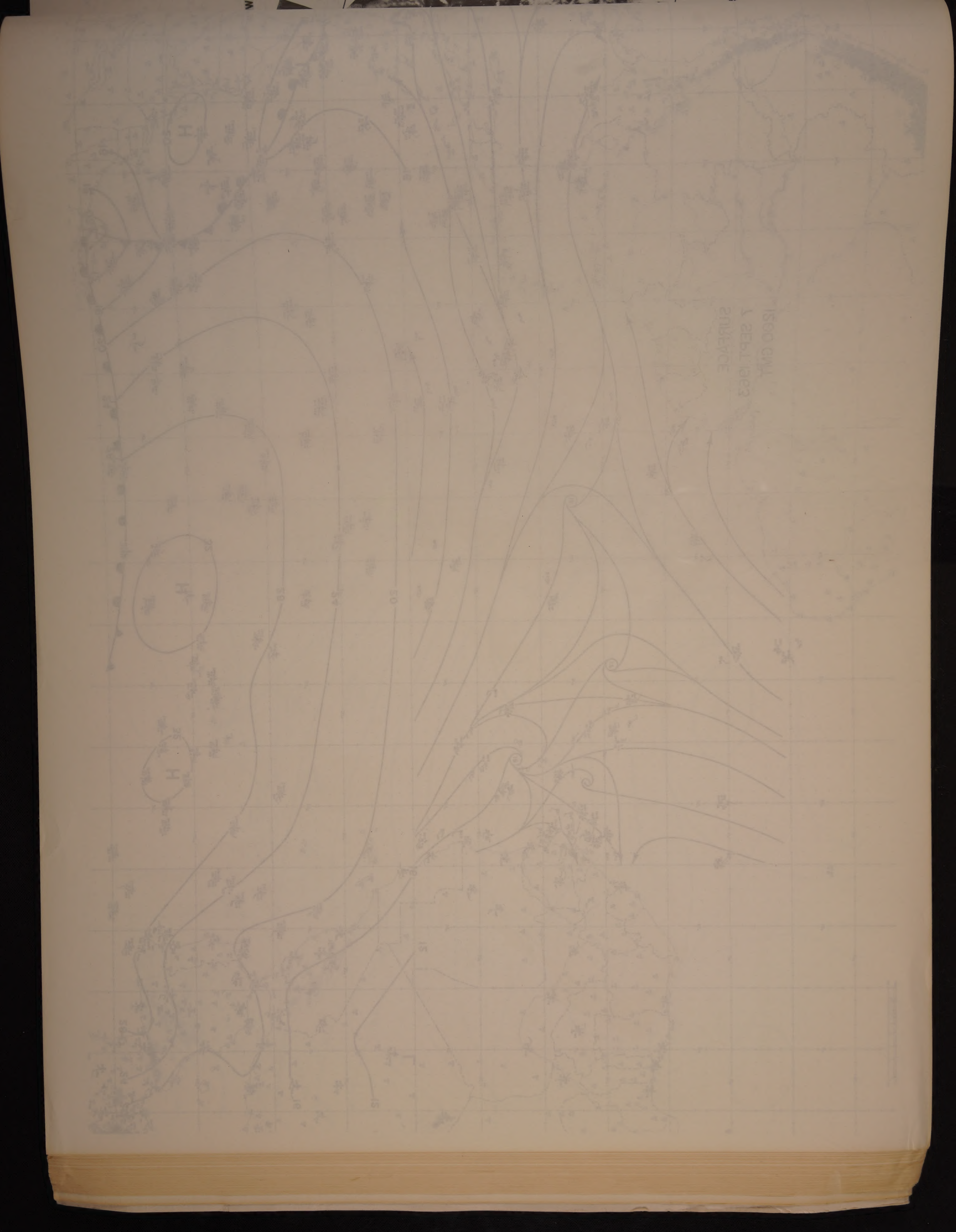
6 SEPTEMBER 1963



CLOUD MAP
06 SEPT. 1963
1200 GMT

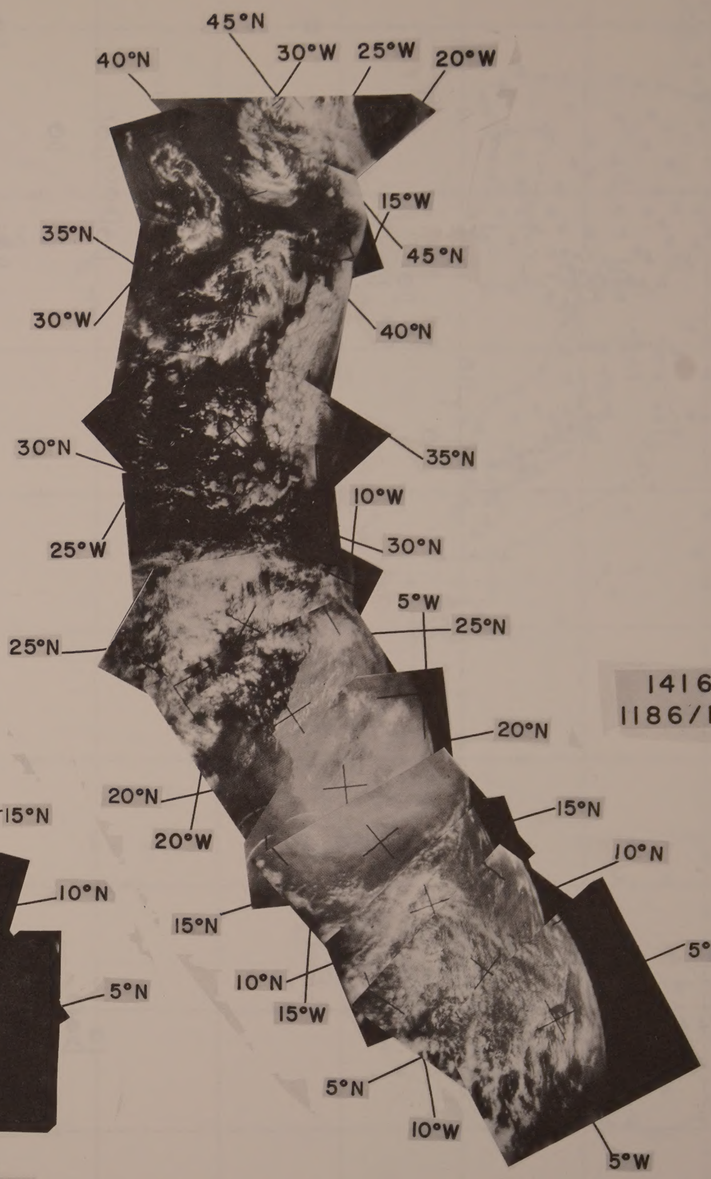

GARDIAN
RANDOLPH
CAMP
S.R.
300mb.
200 MB
06 SEPT. 1963
1200 GMT


SURFACE
7 SEPT. 1963
1200 GMT



1914Z
1189/1188

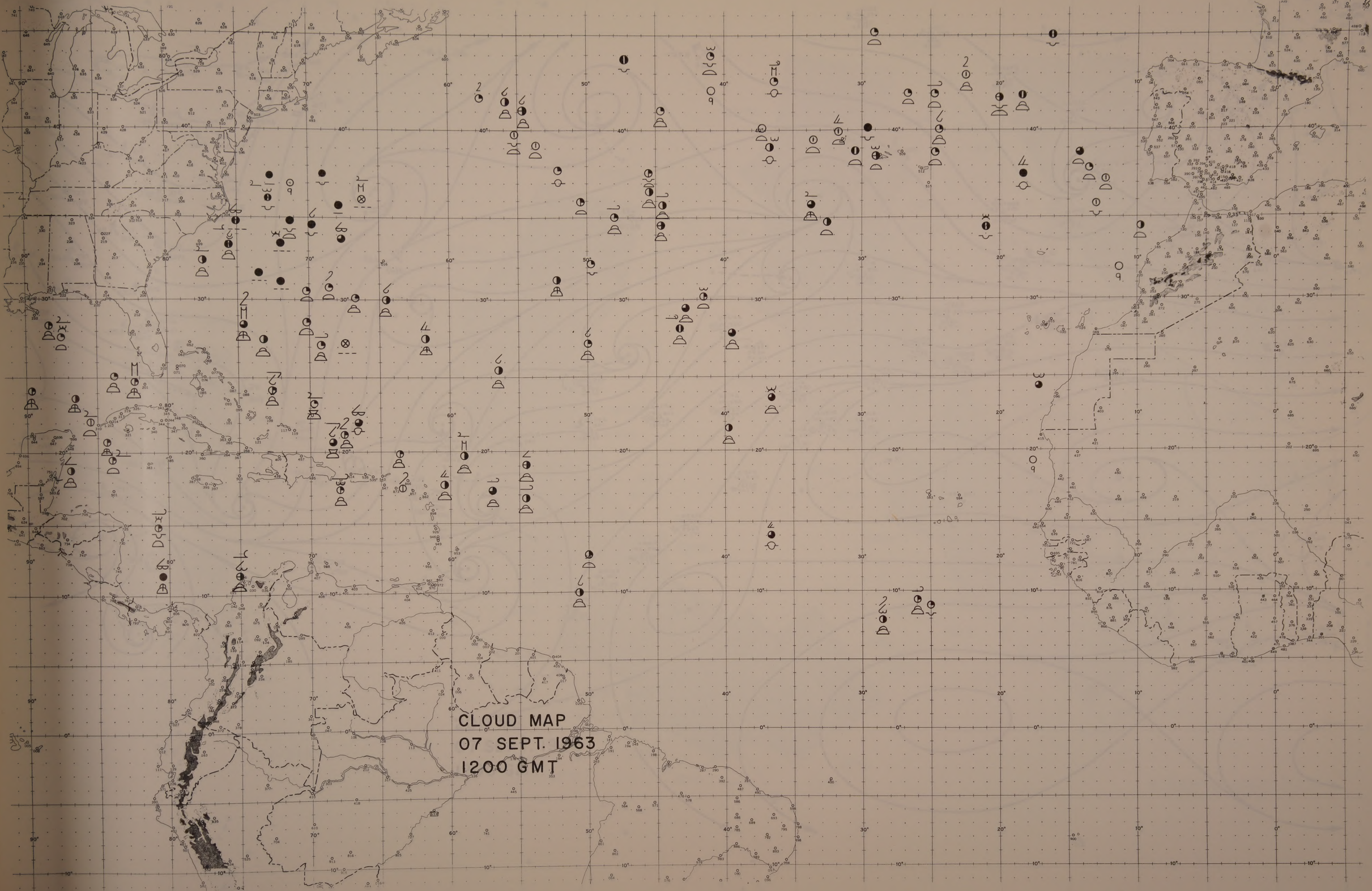
1731Z
1188/1187



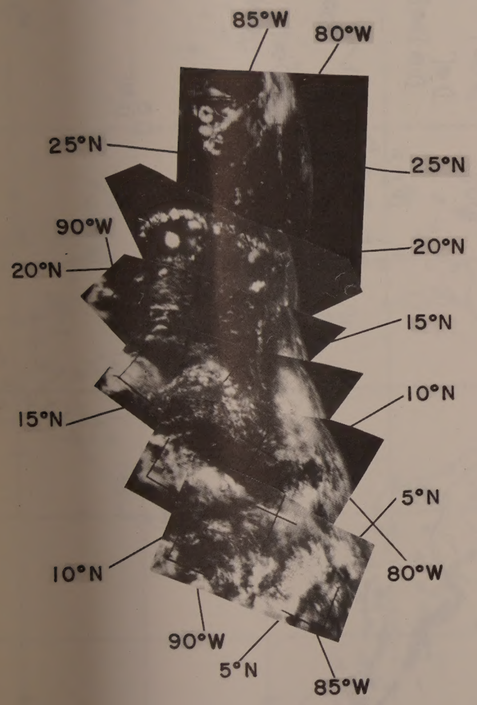
1558Z
1188/1186

1416Z
1186/1185

7 SEPTEMBER 1963

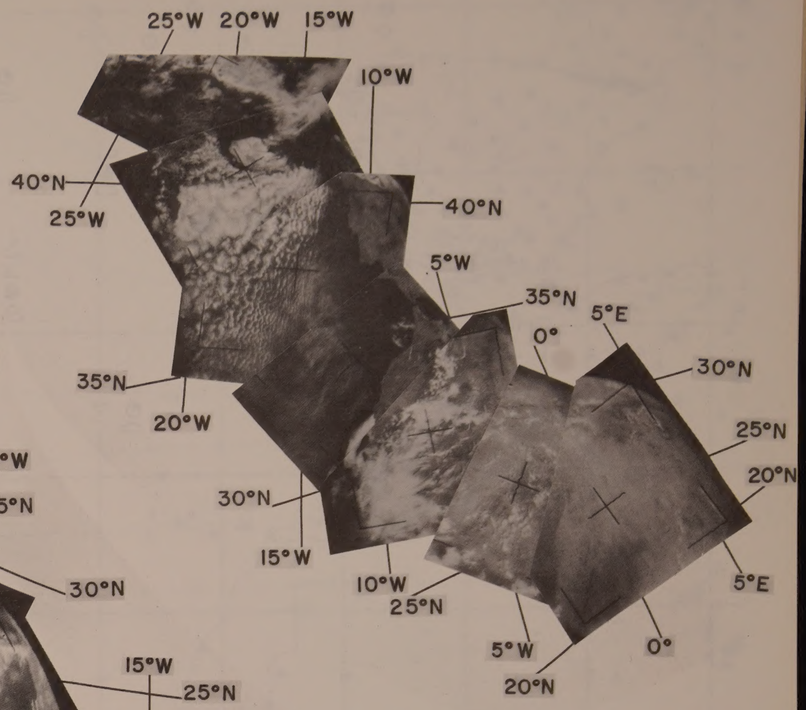

CLOUD MAP
07 SEPT. 1963
1200 GMT

200 MB
07 SEPT. 1963
1200 GMT

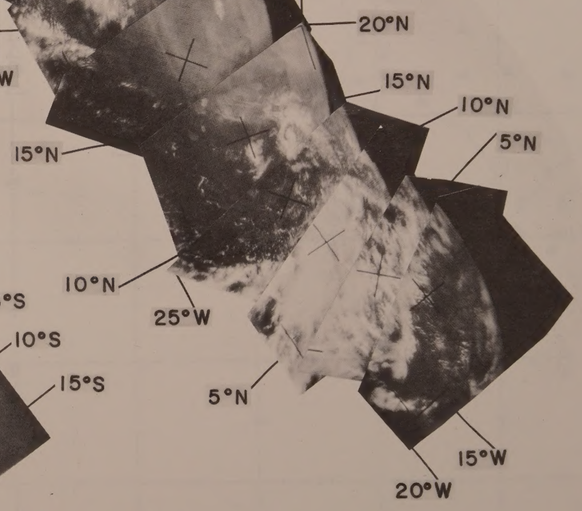


1925Z
5186/5184

1622Z
1203/1201



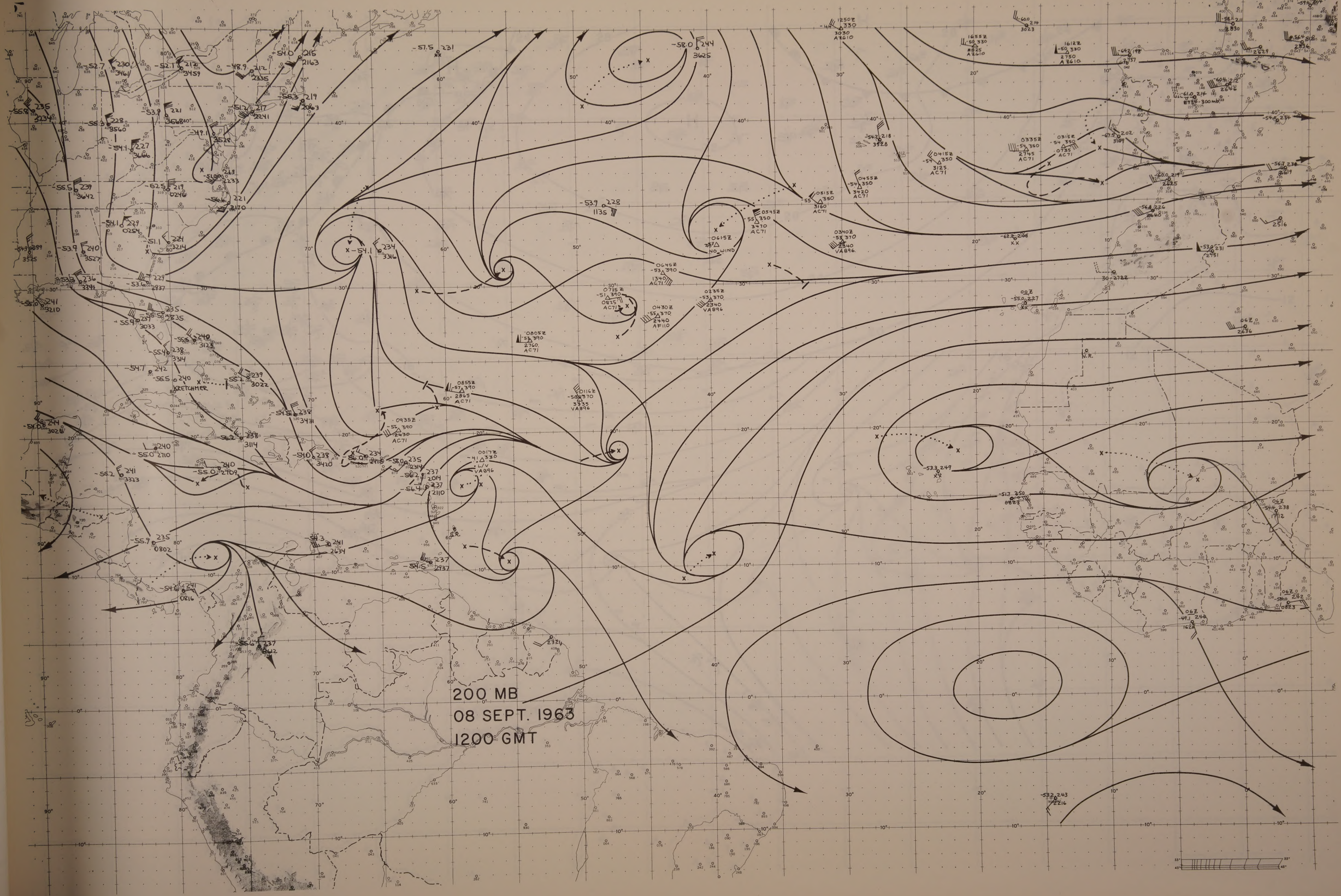
1254Z
1201/1199



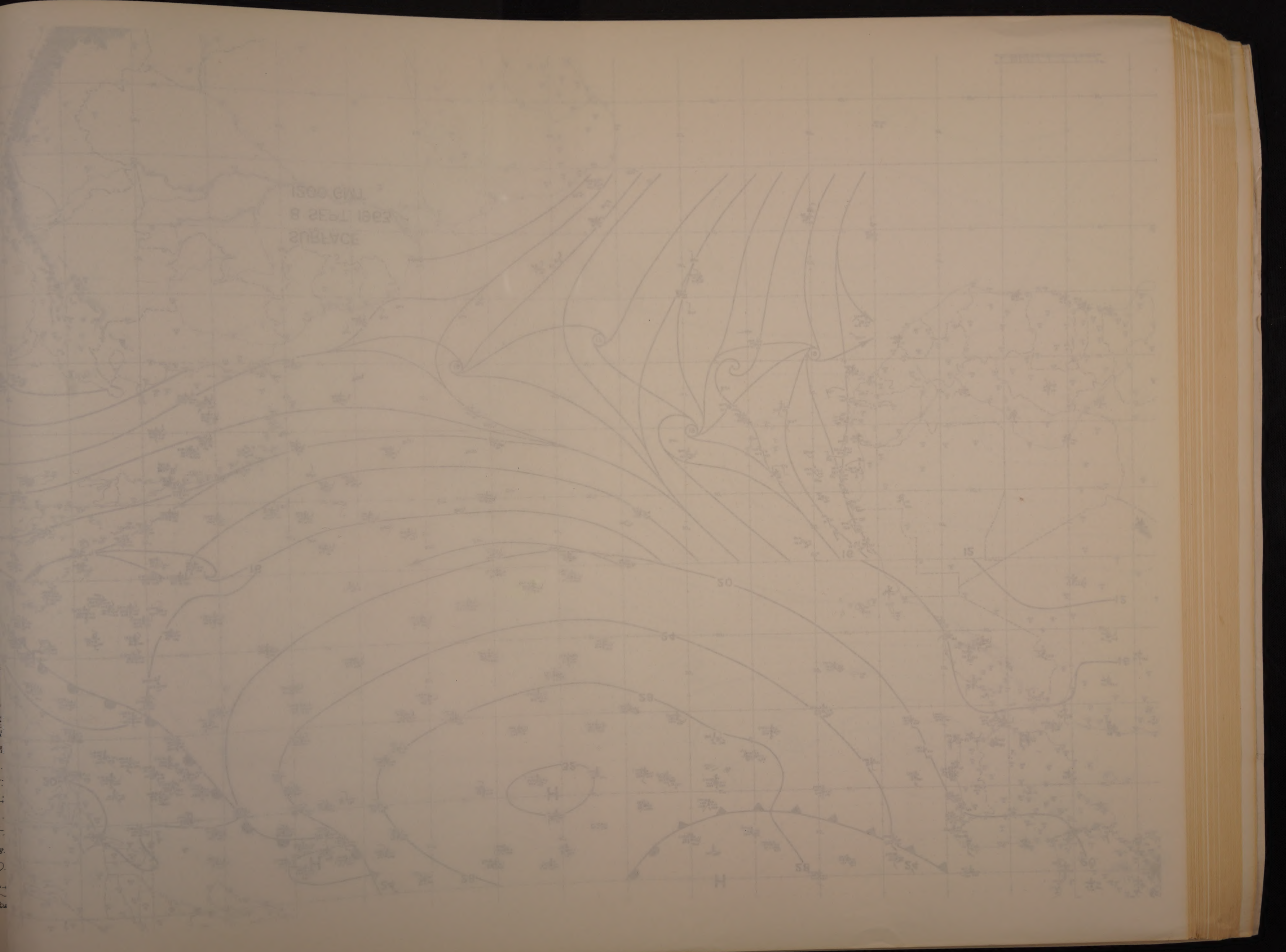
1438Z
1201/1200

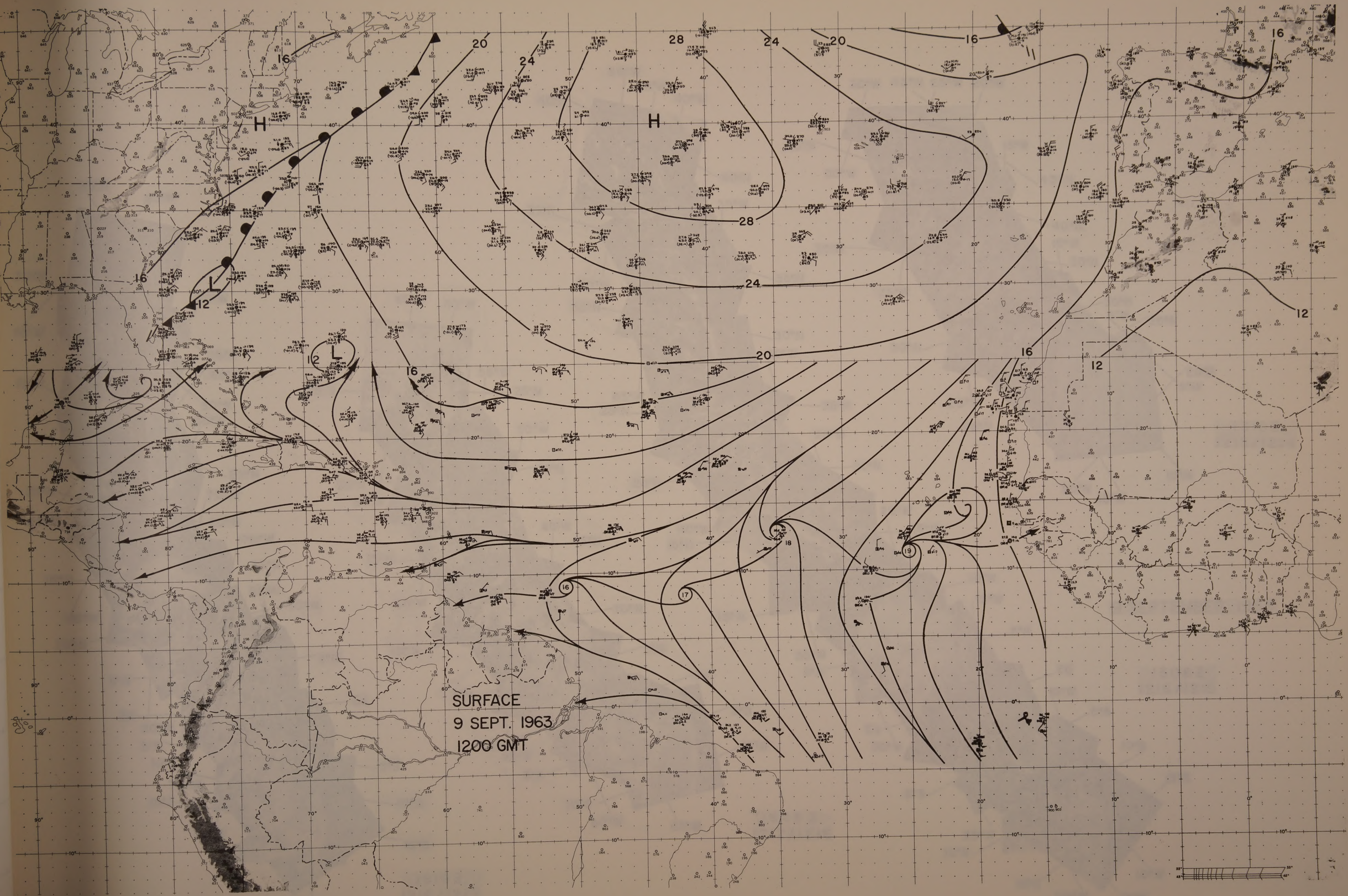
8 SEPTEMBER 1963

CLOUD MAP
08 SEPT. 1963
1200 GMT

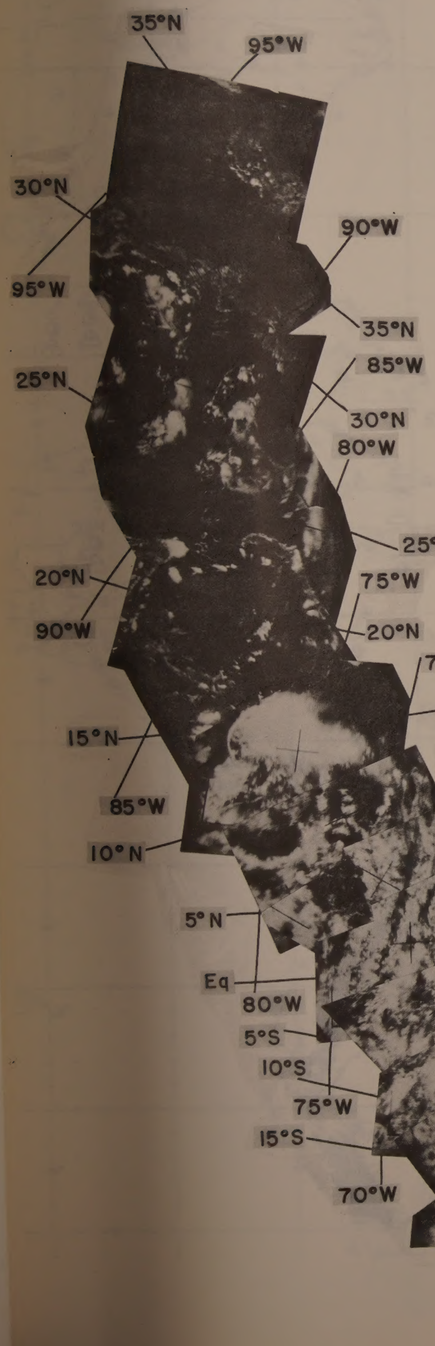

200 MB
08 SEPT. 1963
1200 GMT
KRETCHMER

SURFACE
8 SEPT. 1963
1200 GMT

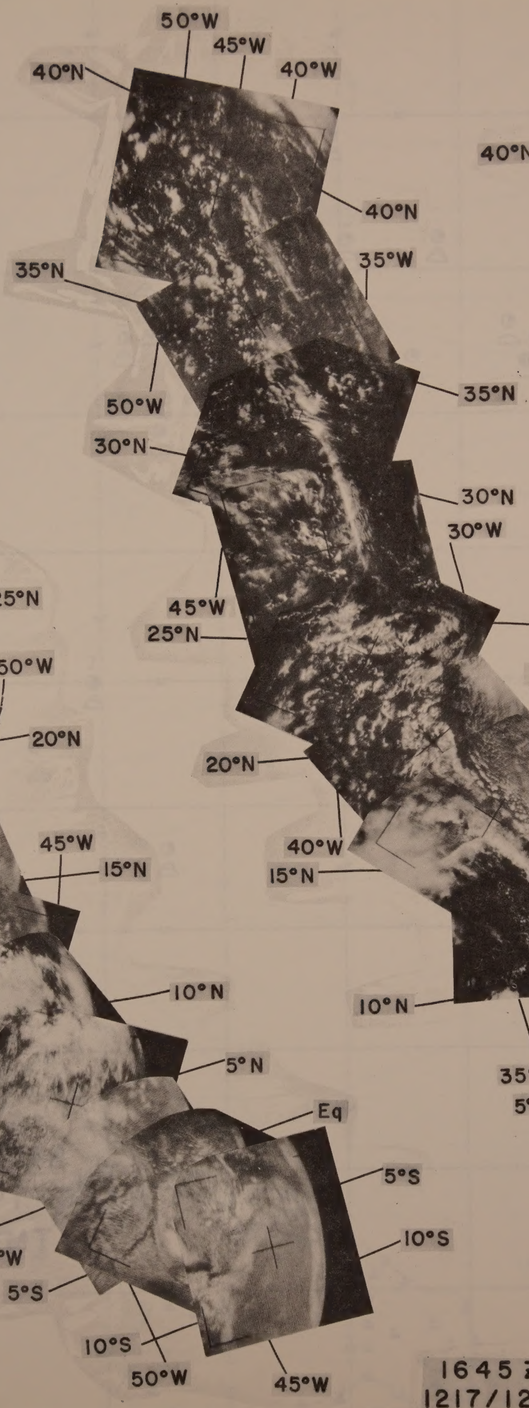

H
H
H
50
15
10


SURFACE
9 SEPT. 1963
1200 GMT

PDARBUS
ESB TPBS 8
1500 0051



1819 Z
1218/1217

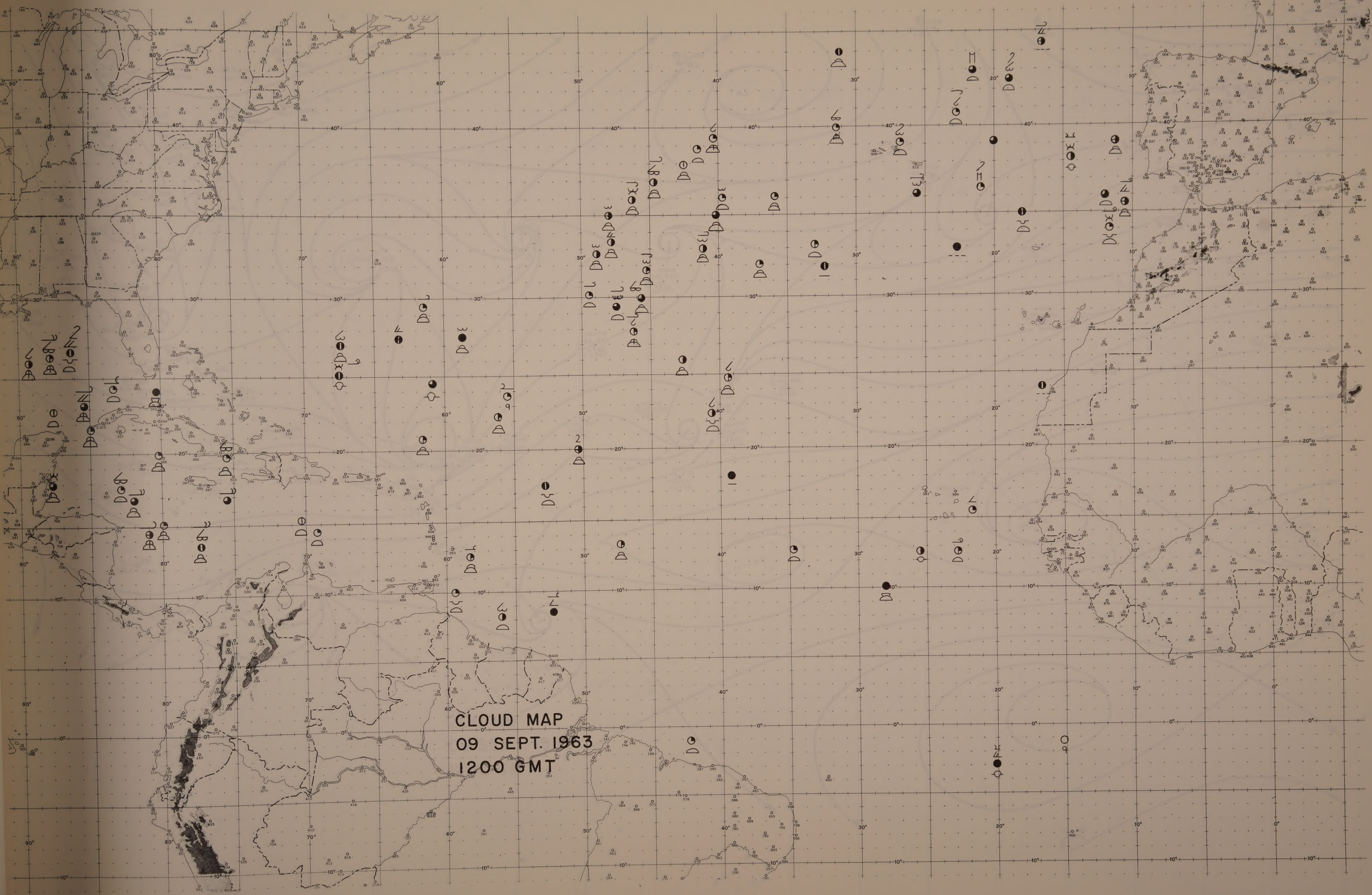


1645 Z
1217/1216

1315 Z
1215/1214

9 SEPTEMBER 1963

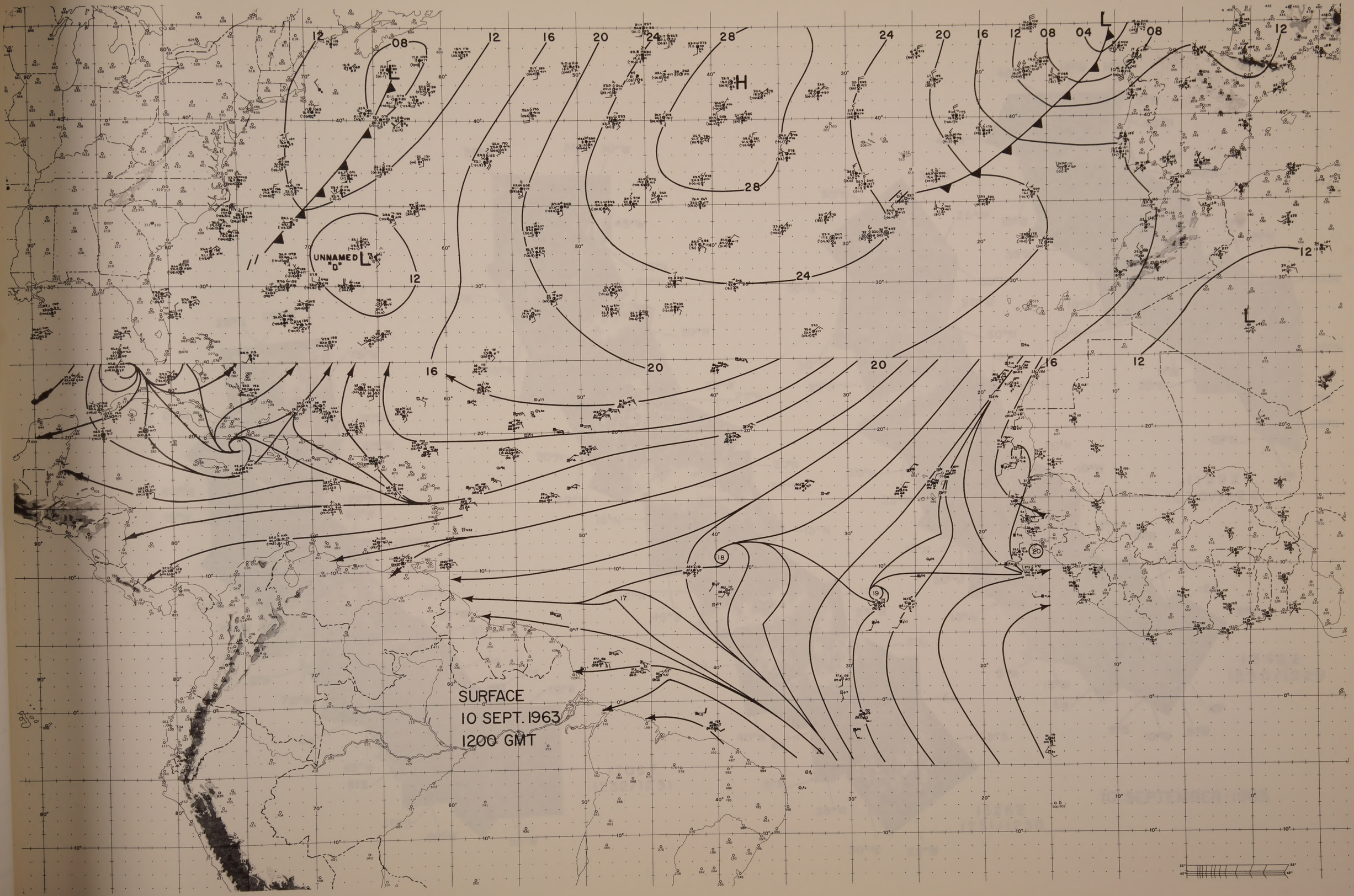
1508 Z
1216/1215

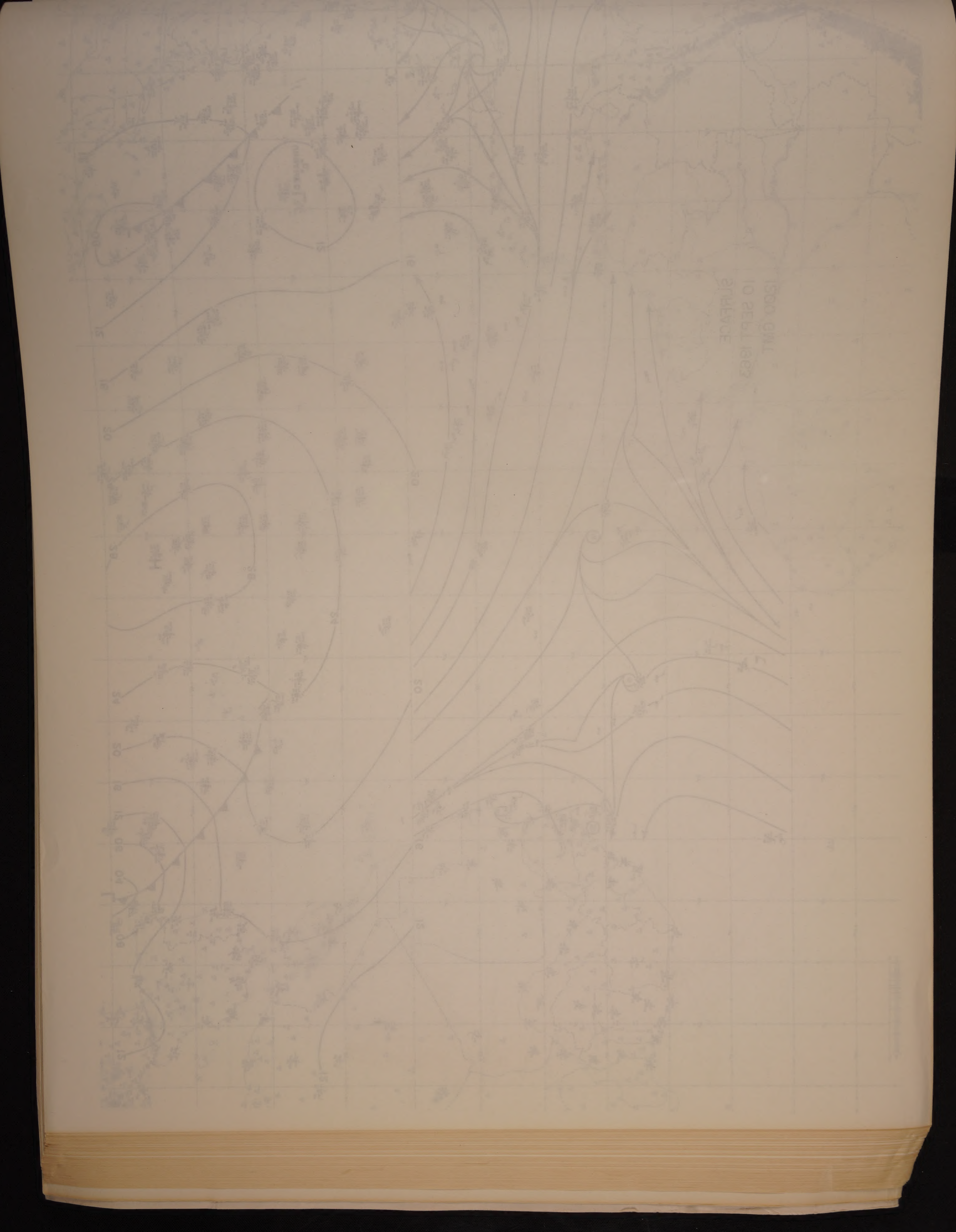

CLOUD MAP
09 SEPT. 1963
1200 GMT

200 MB

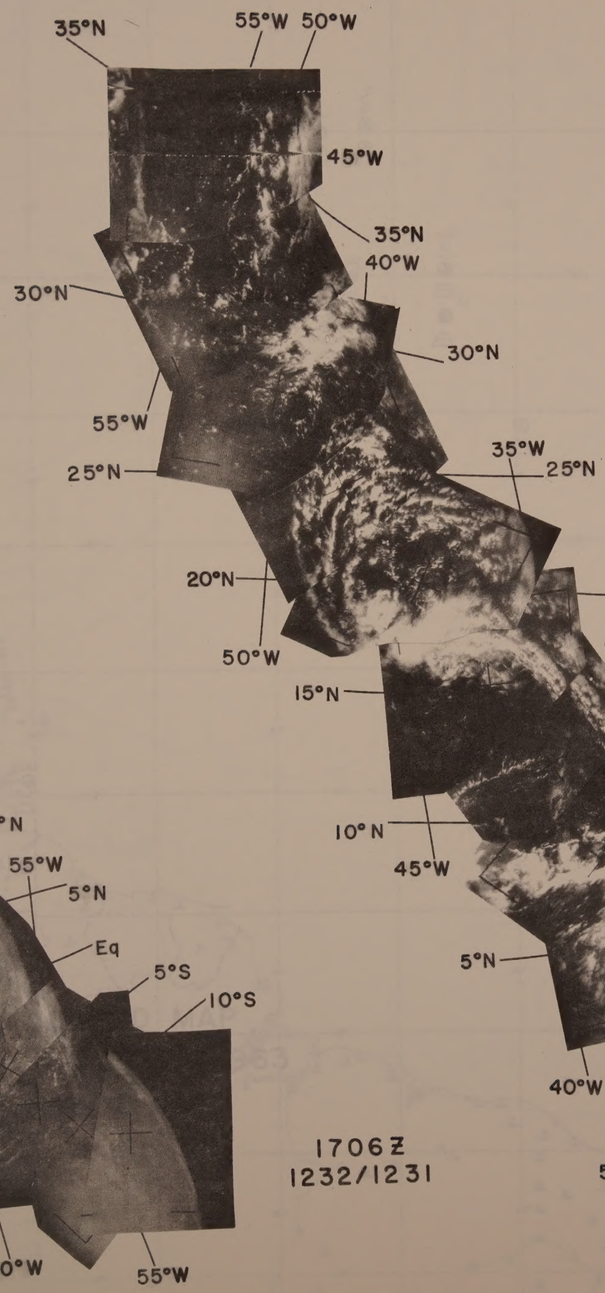
09 SEPT. 1963

1200 GMT

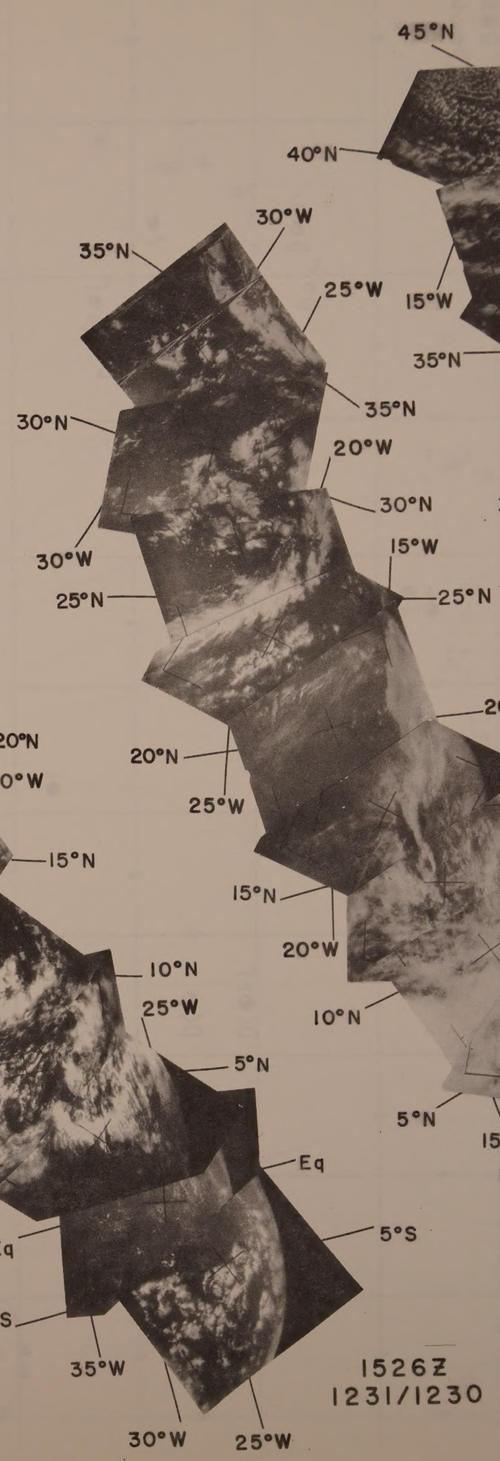

UNNAMED "D"
SURFACE
10 SEPT. 1963
1200 GMT



1706Z
1232/1231



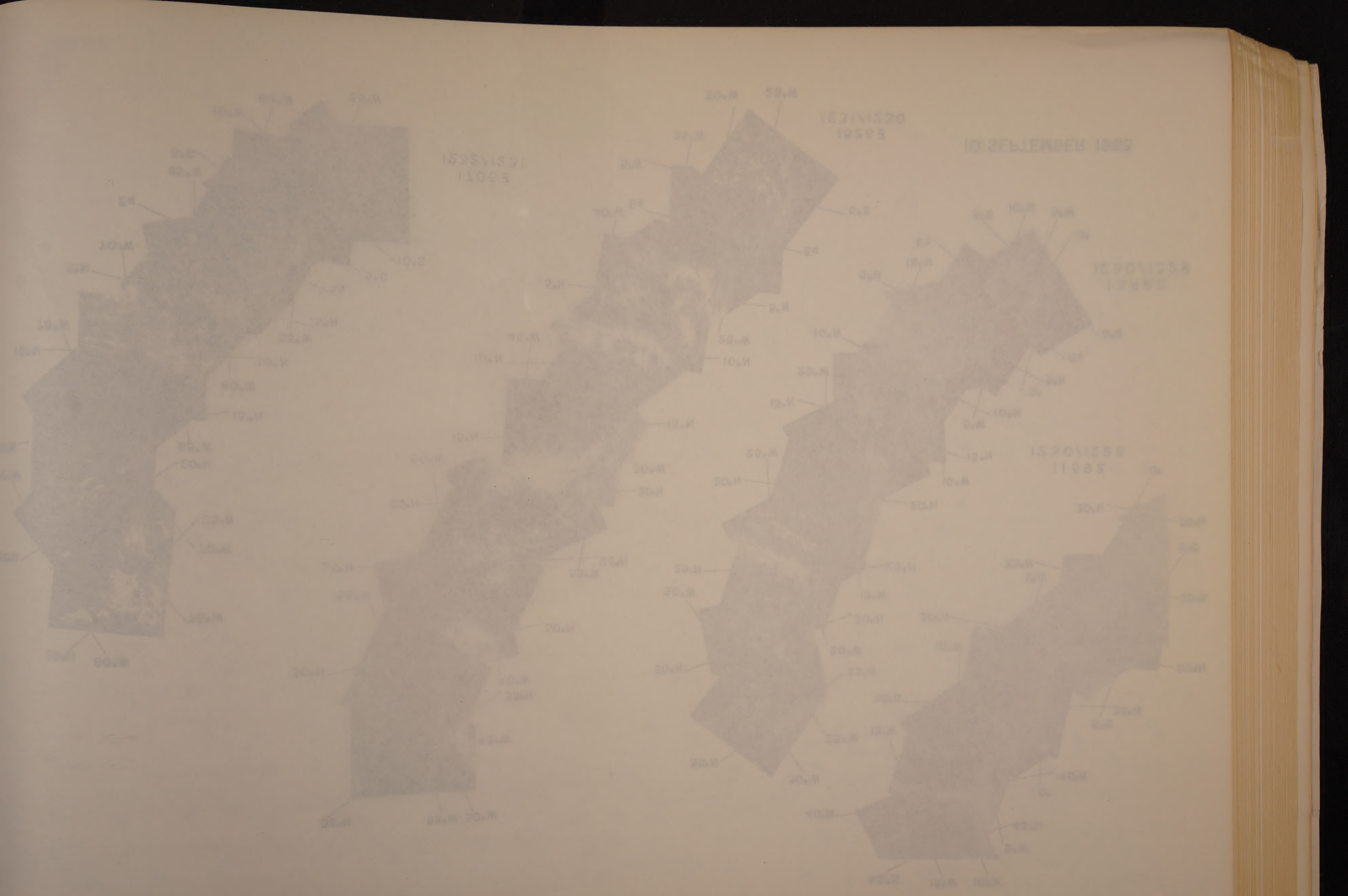
1526Z
1231/1230



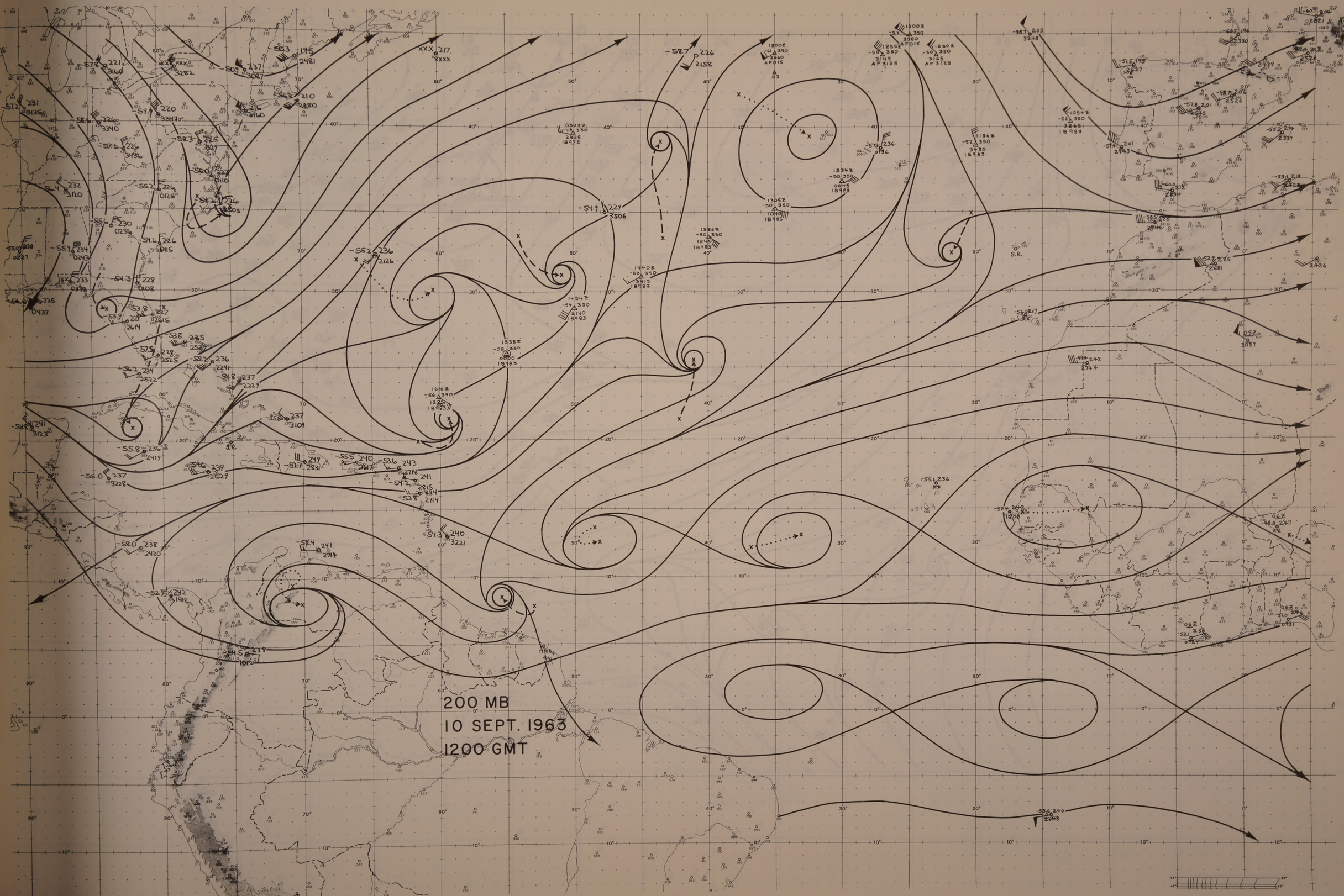
1159Z
1230/1228

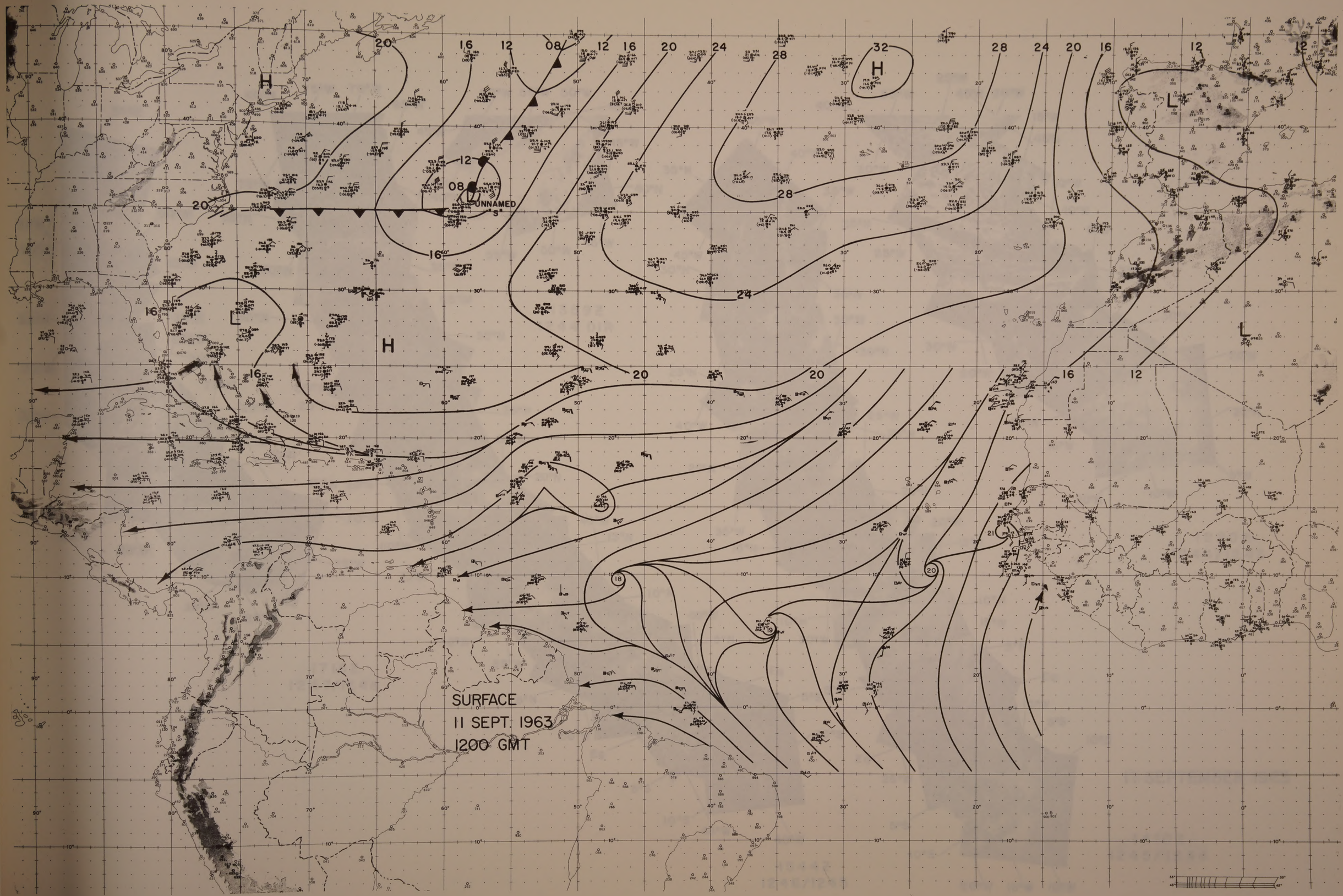
1348Z
1230/1229

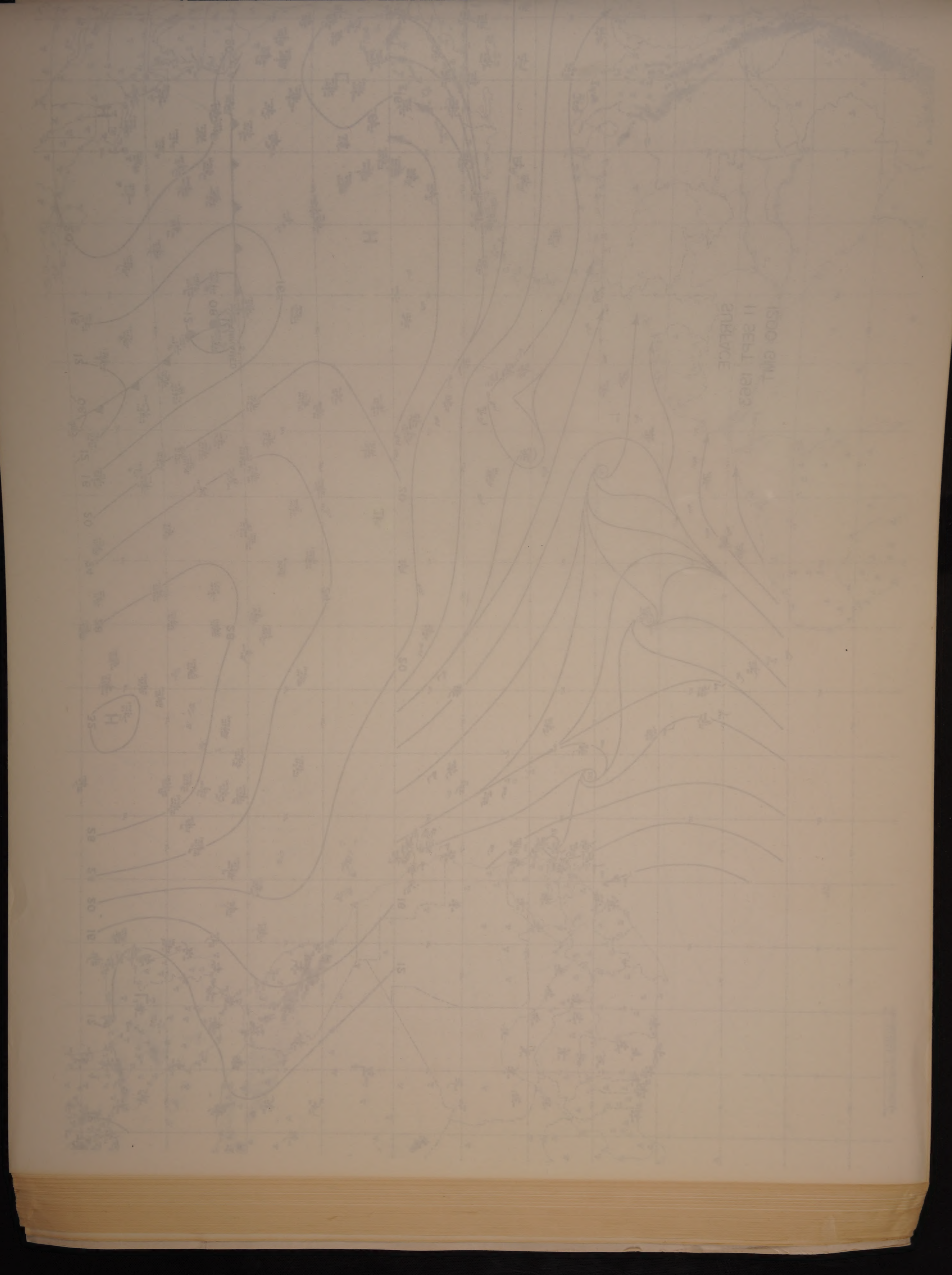
10 SEPTEMBER 1963



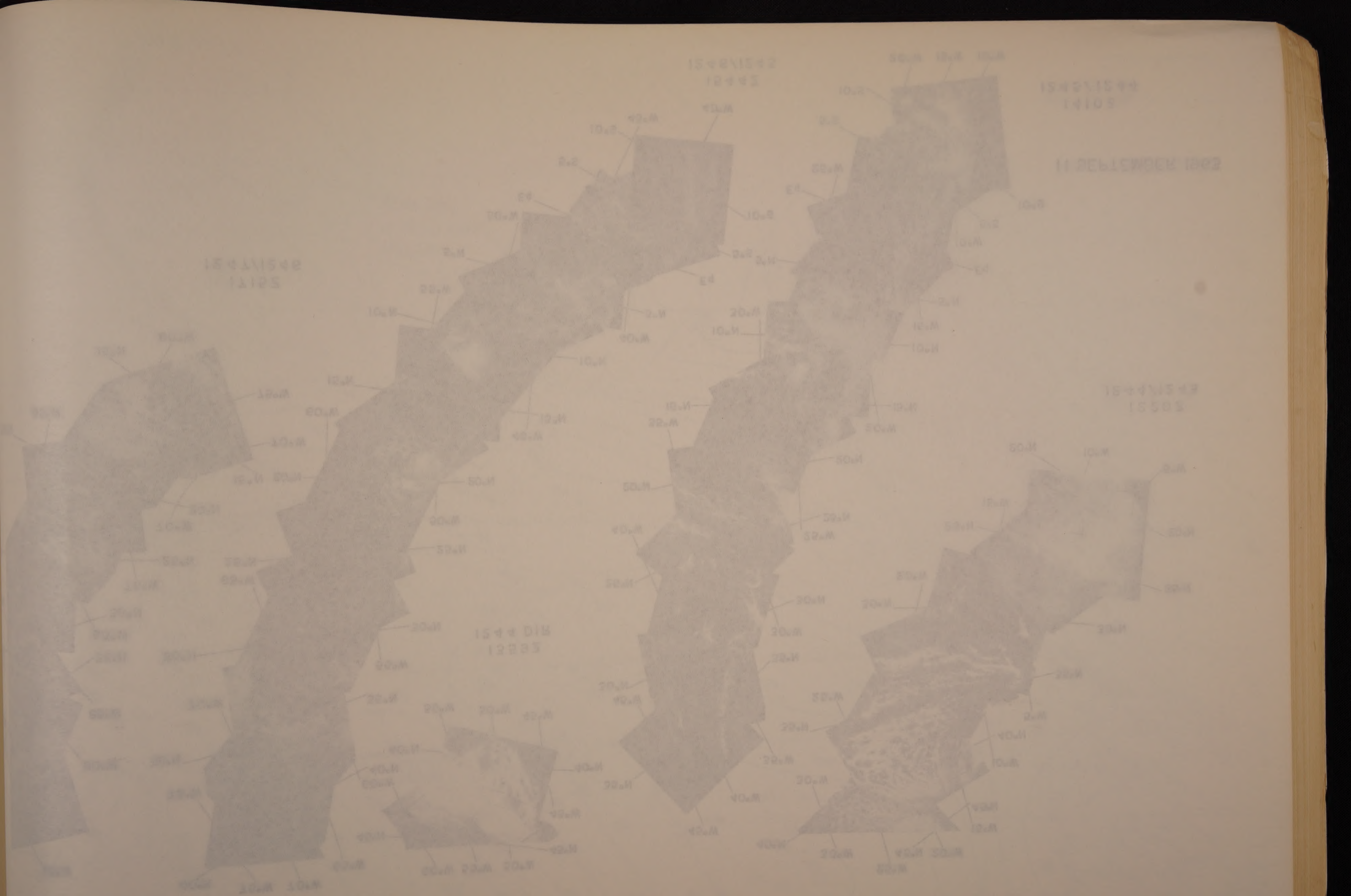
CLOUD MAP
10 SEPT. 1963
1200 GMT


200 MB
10 SEPT. 1963
1200 GMT

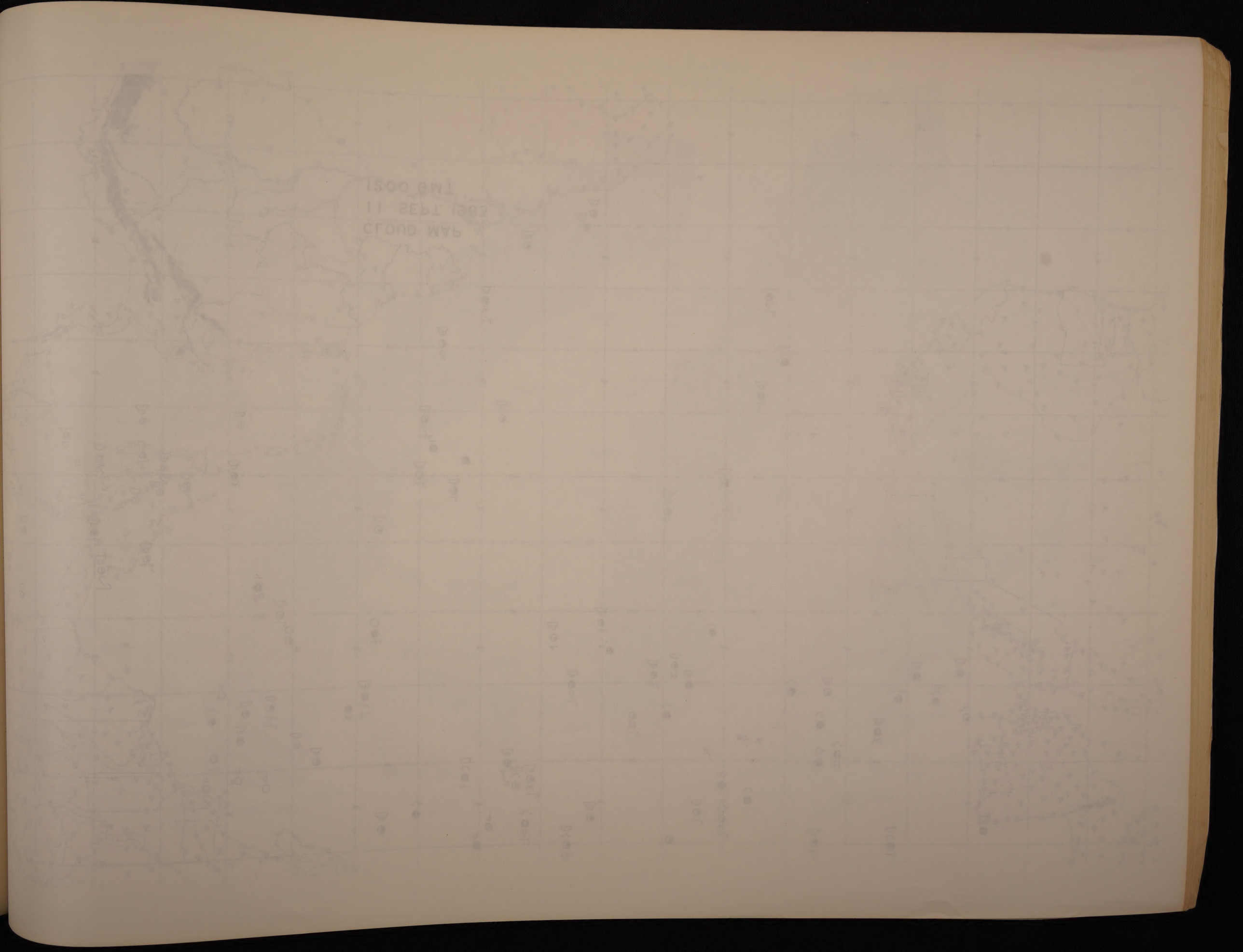

UNNAMED
SURFACE
11 SEPT. 1963
1200 GMT

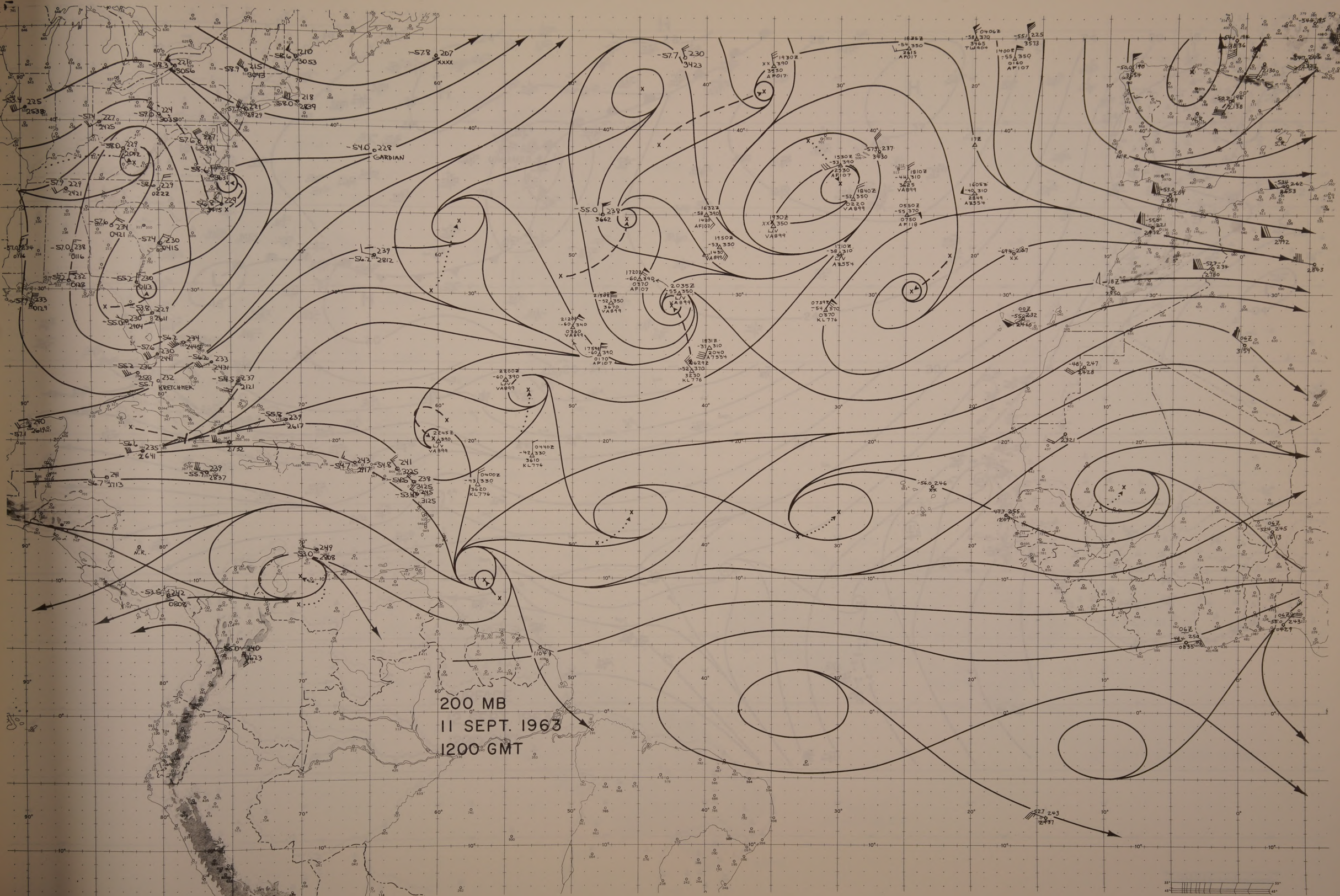

ISOBARE
SOLL-LAGE
ZENTRUM

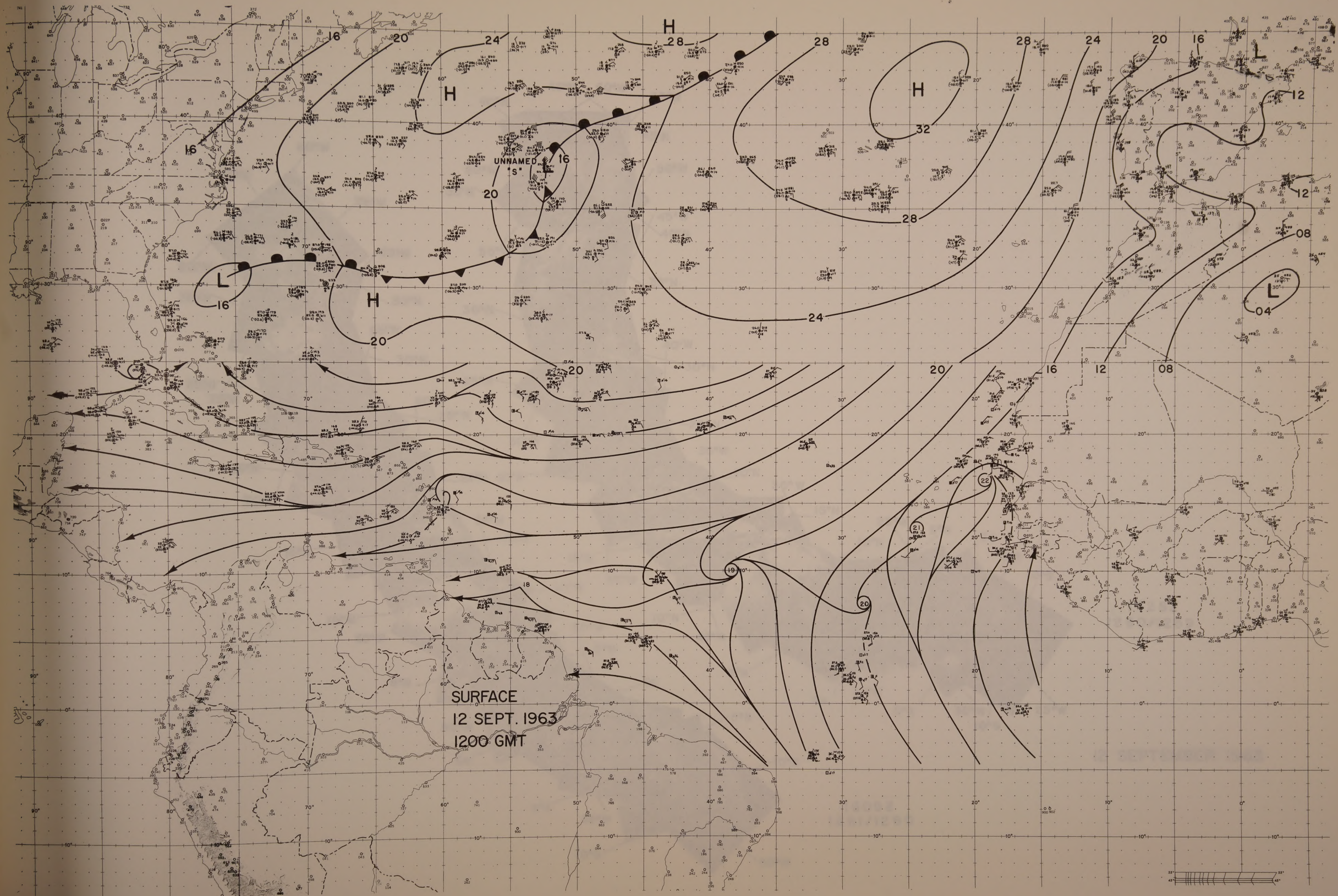
11 SEPTEMBER 1963

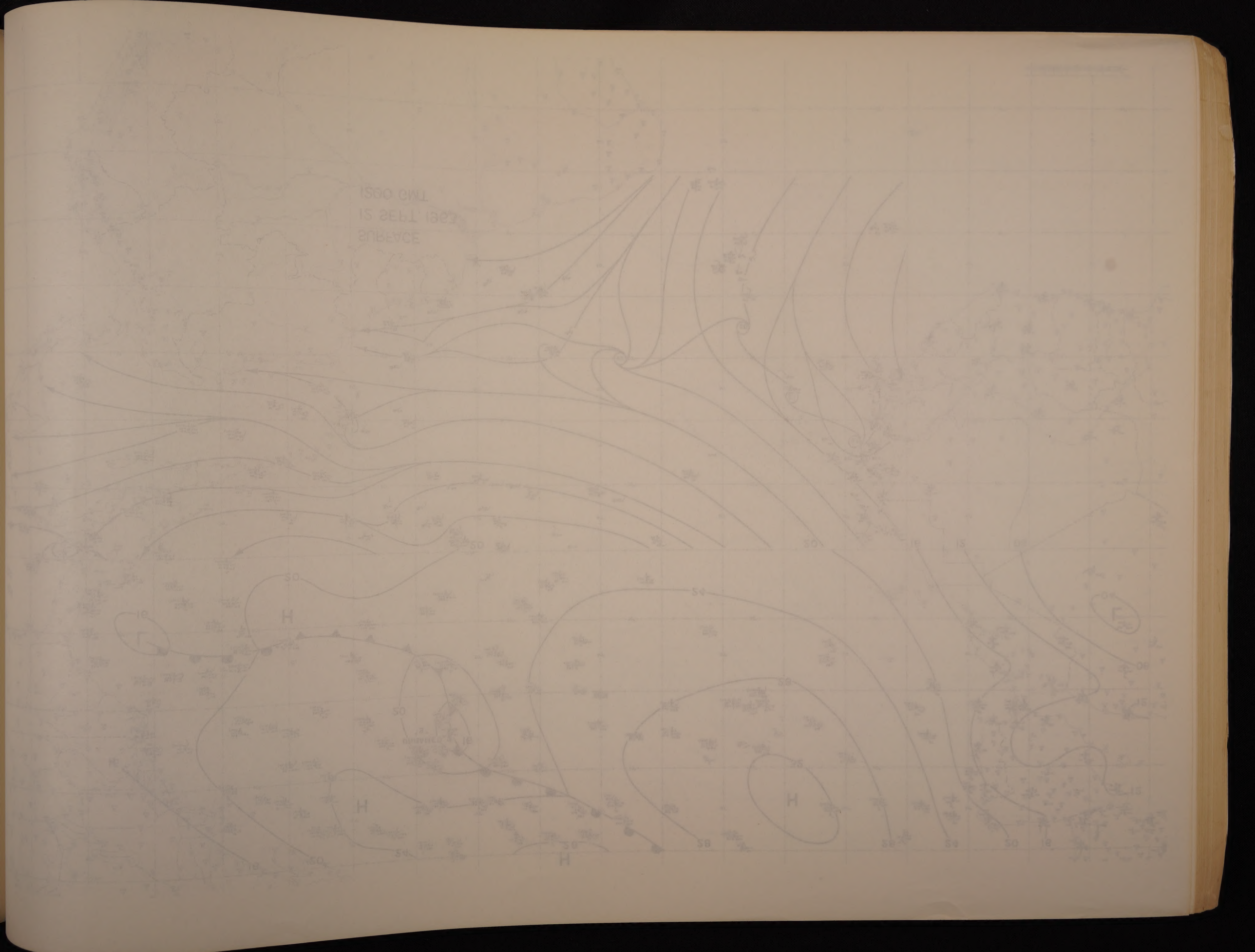


CLOUD MAP
11 SEPT. 1963
1200 GMT




200 MB
11 SEPT. 1963
1200 GMT
KRETCHMER
GARDIAN
N.R.


UNNAMED "S"
SURFACE
12 SEPT. 1963
1200 GMT

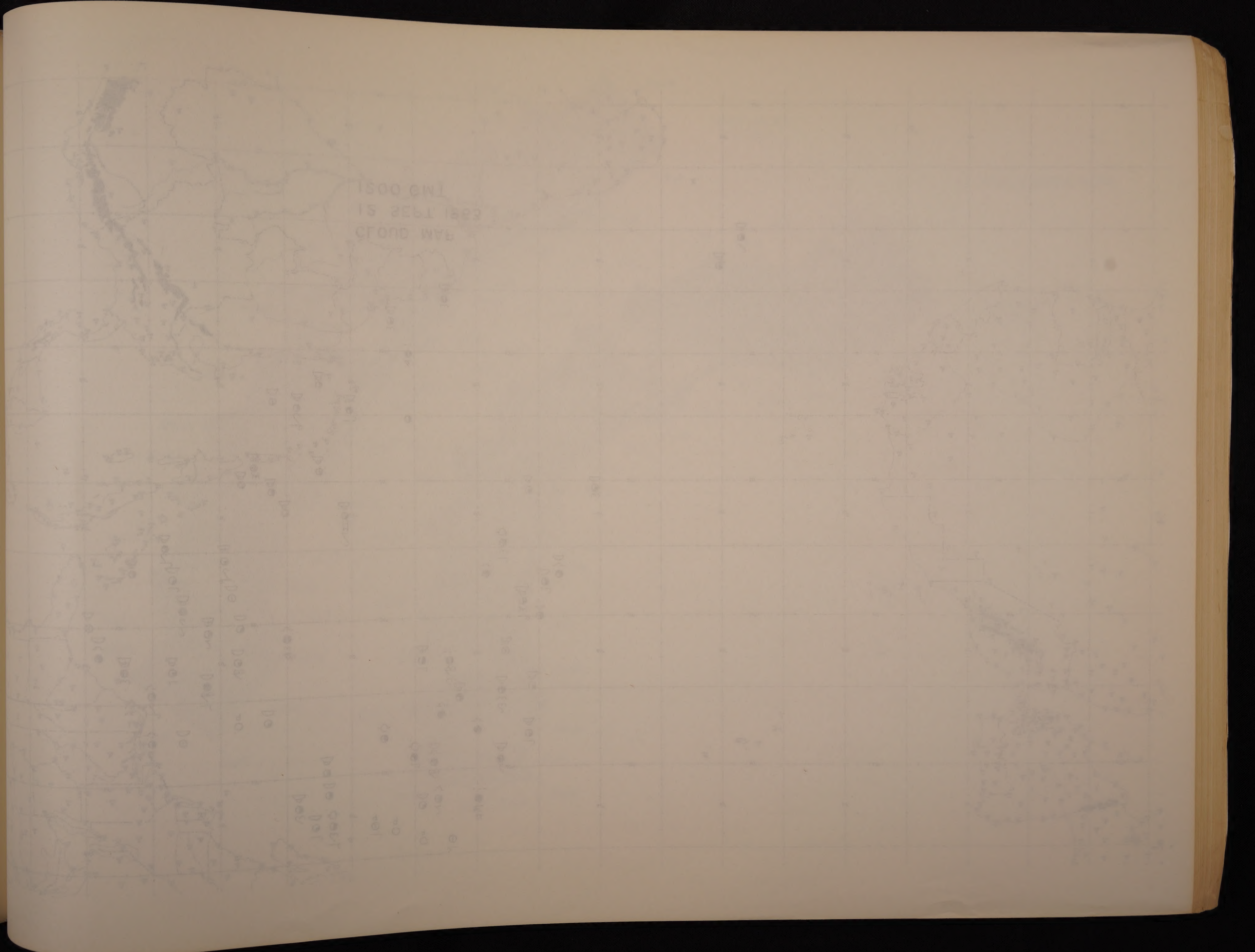

1500 GMT
15 SEPT 1952
SURFACE
H
H
H
H
50
50
50

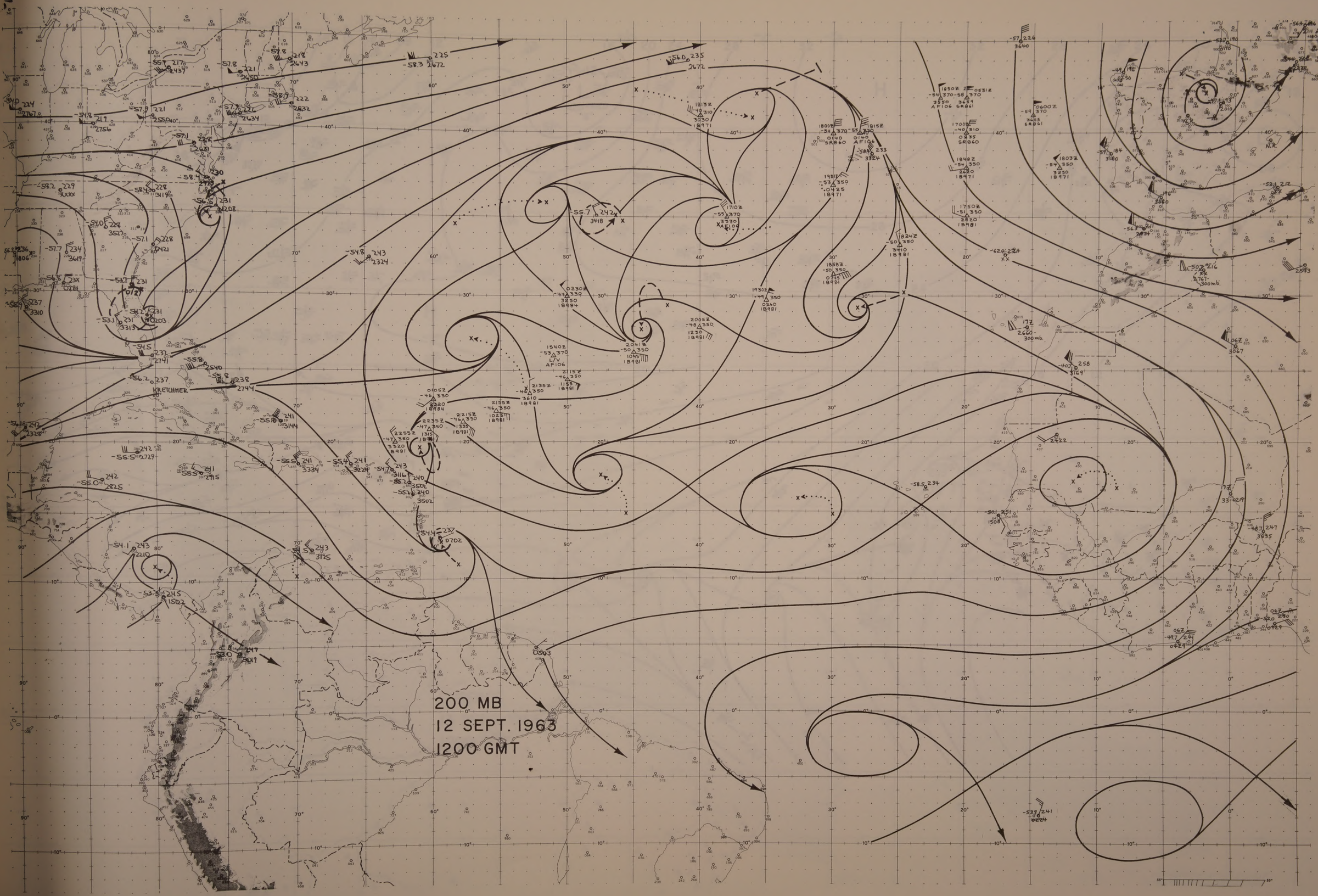
1428Z
1260/1259

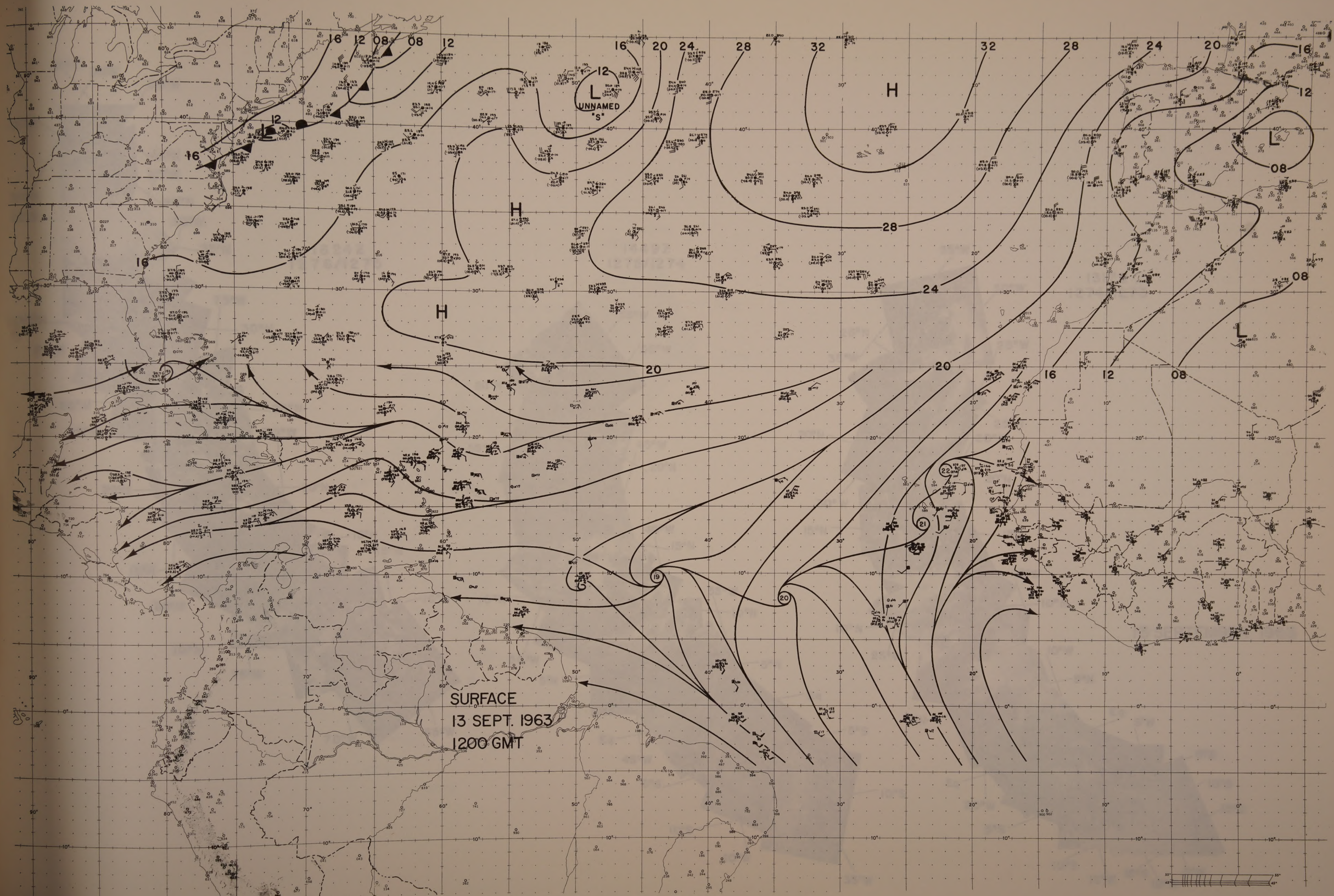
1609Z
1261/1260

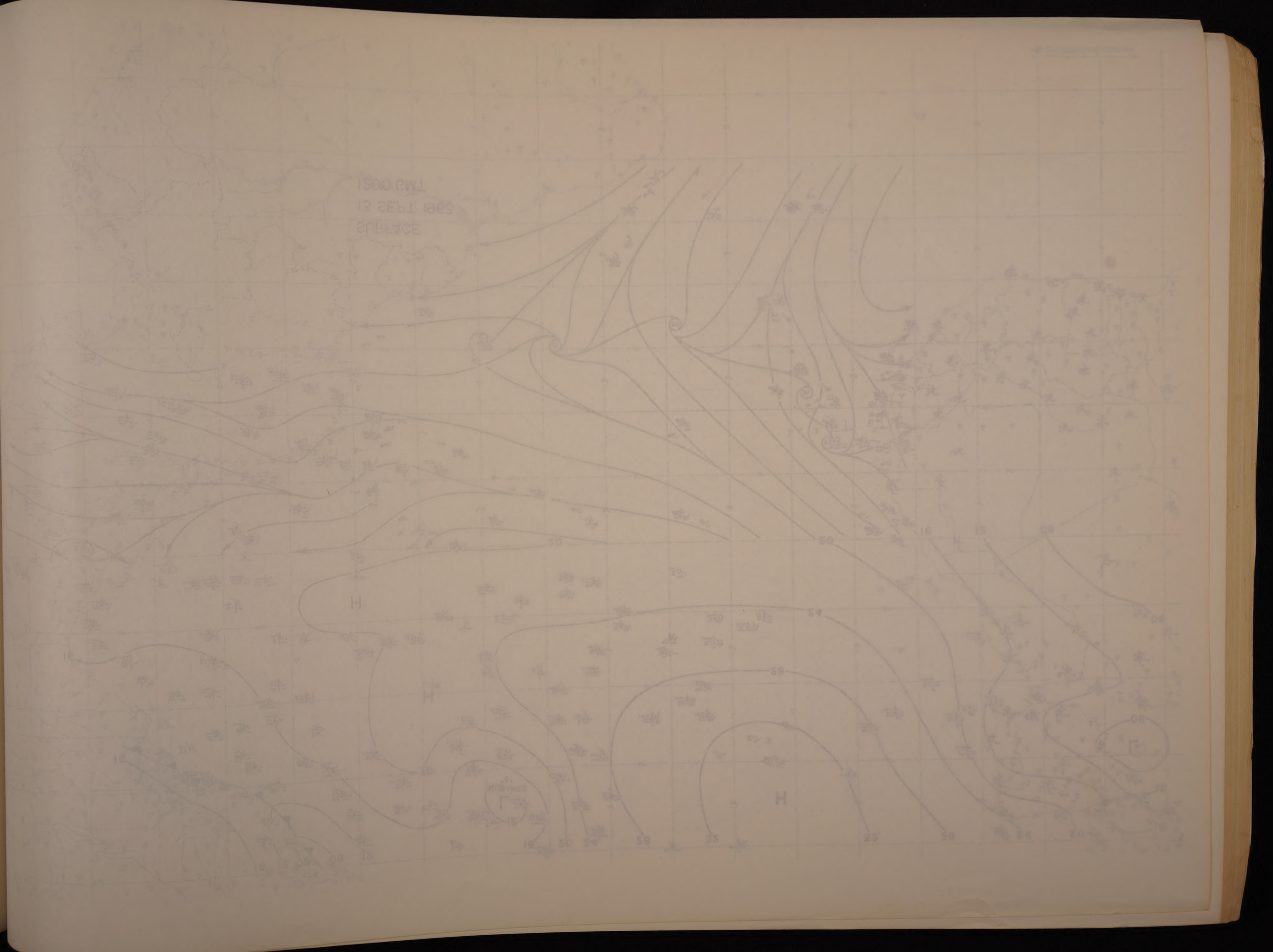
12 SEPTEMBER 1963

CLOUD MAP
12 SEPT. 1963
1200 GMT



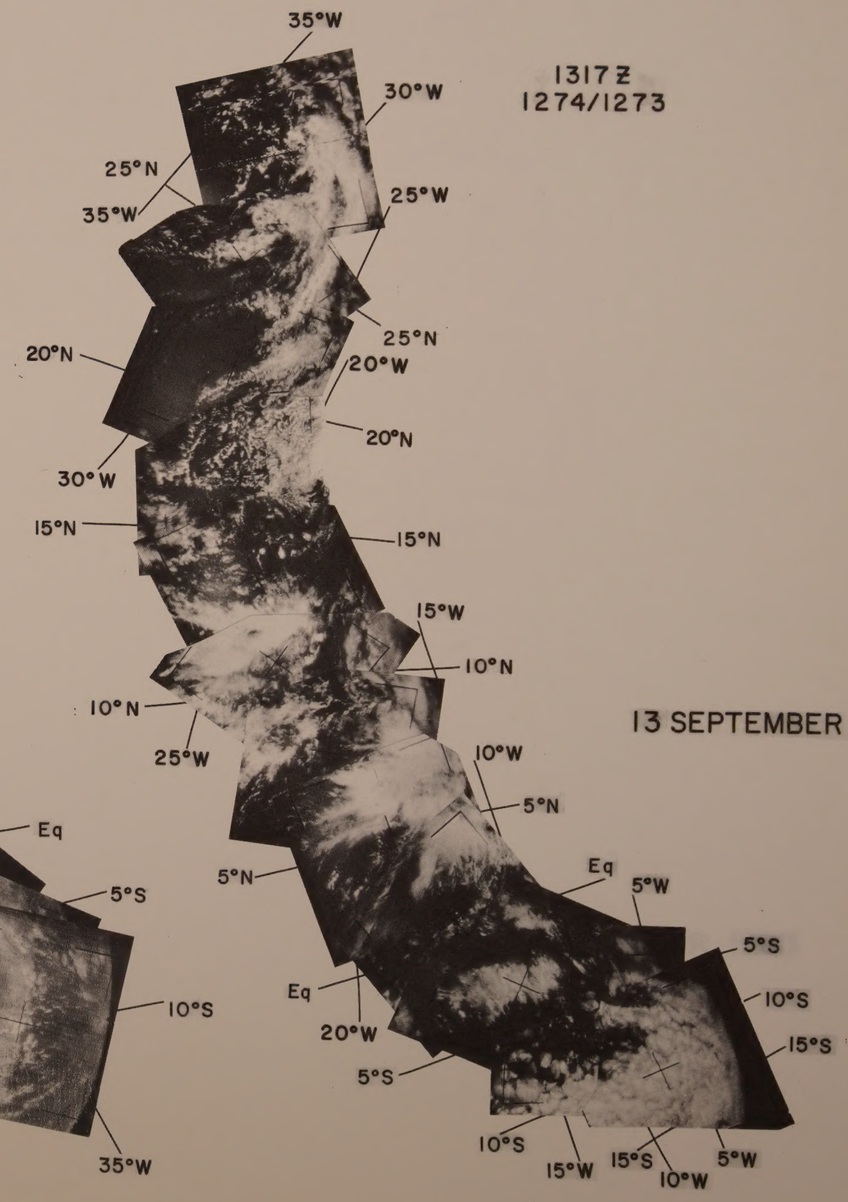

200 MB
12 SEPT. 1963
1200 GMT


L
UNNAMED
"S"
H
H
H
L
L
L
L
16
12
08
08
12
16
20
24
28
32
32
28
24
20
16
12
08
08
12
16
20
24
28
28
24
20
16
12
08
20
19
20
21
22
SURFACE
13 SEPT. 1963
1200 GMT


1500 GMT
SURFACE
H
H
H
50
50
50

1624Z
1276/1275

1449Z
1275/1274



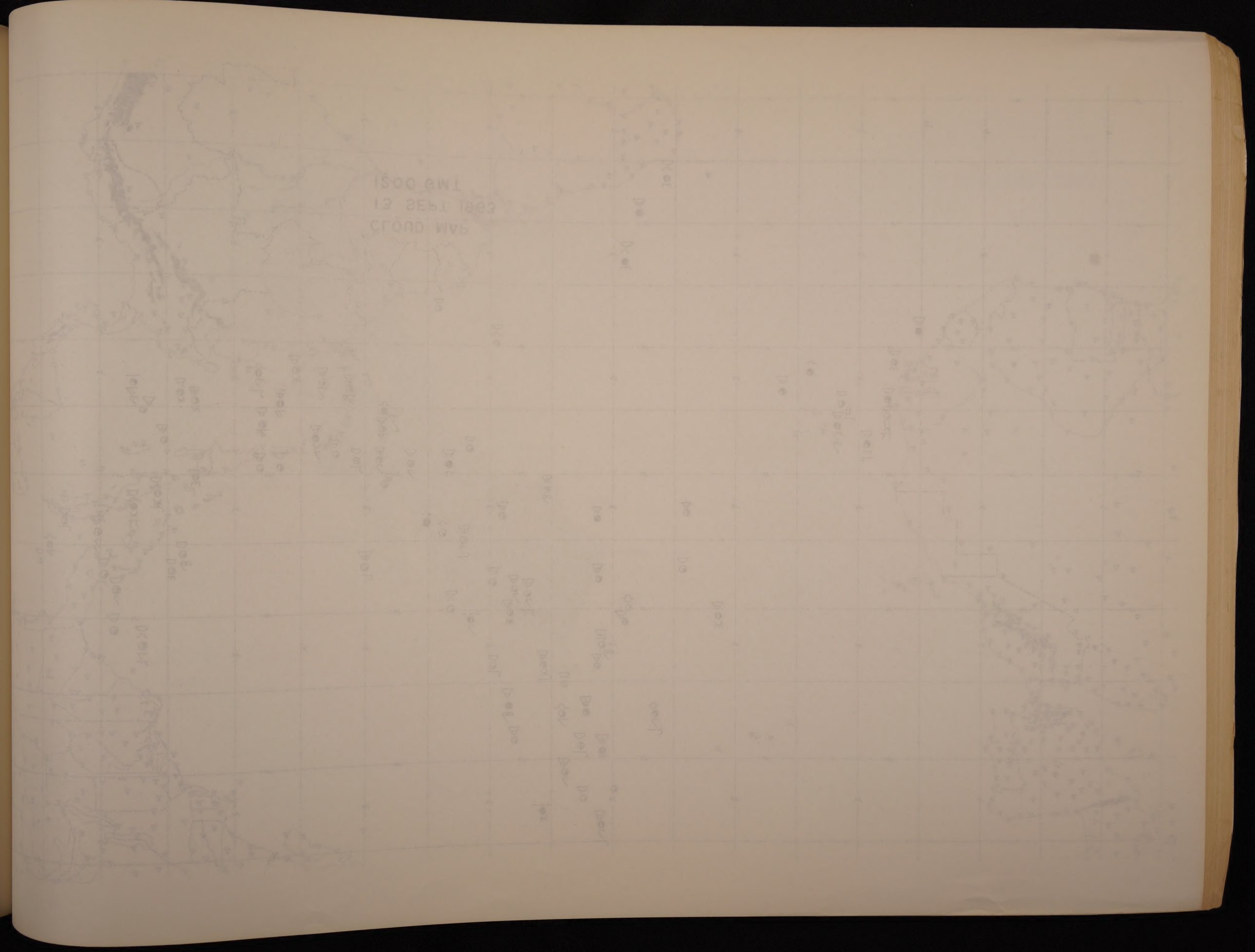
1317Z
1274/1273

13 SEPTEMBER 1963

1621Z
5261/5256

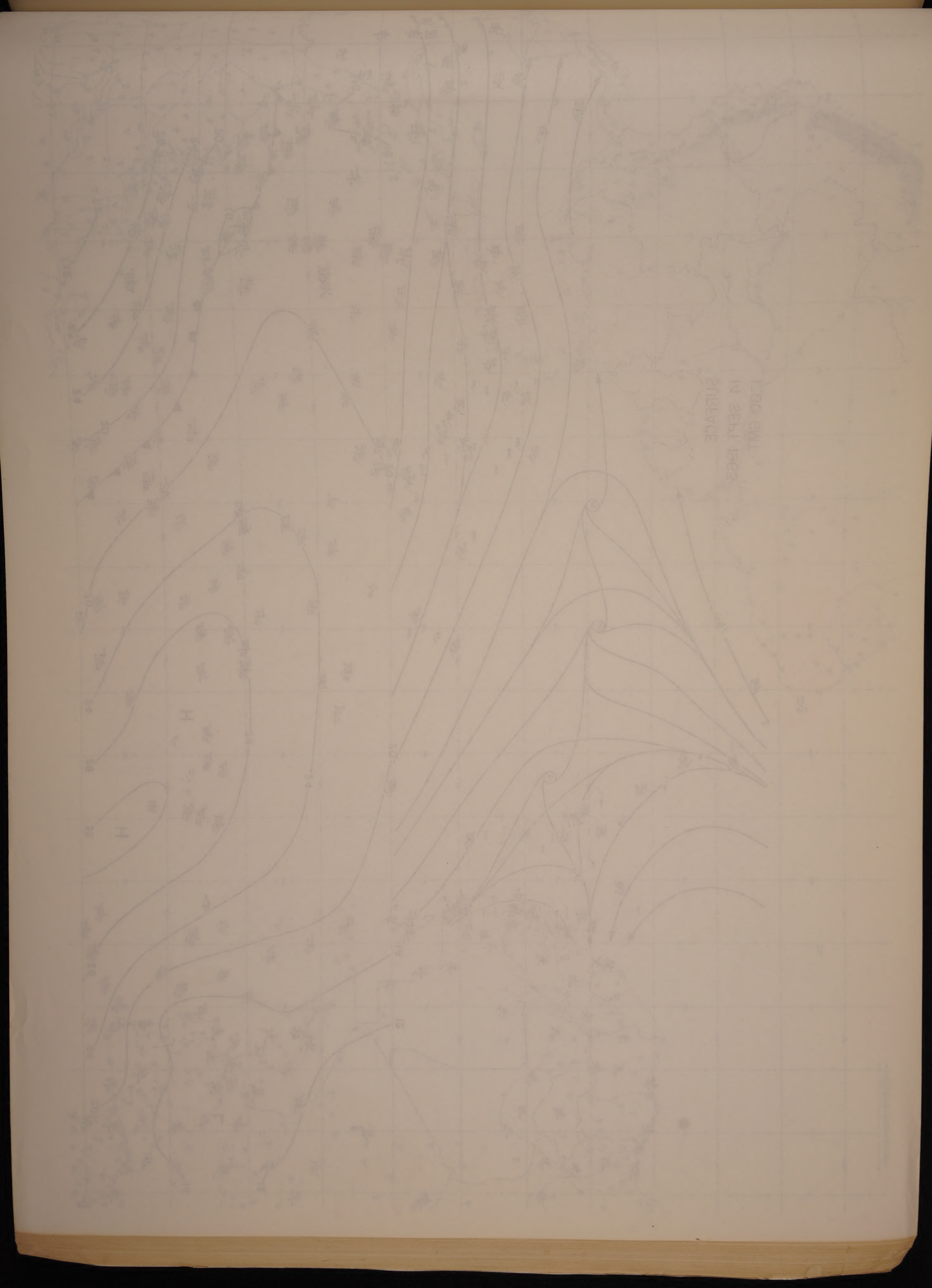
13 SEPTEMBER 1963

CLOUD MAP
13 SEPT. 1963
1200 GMT

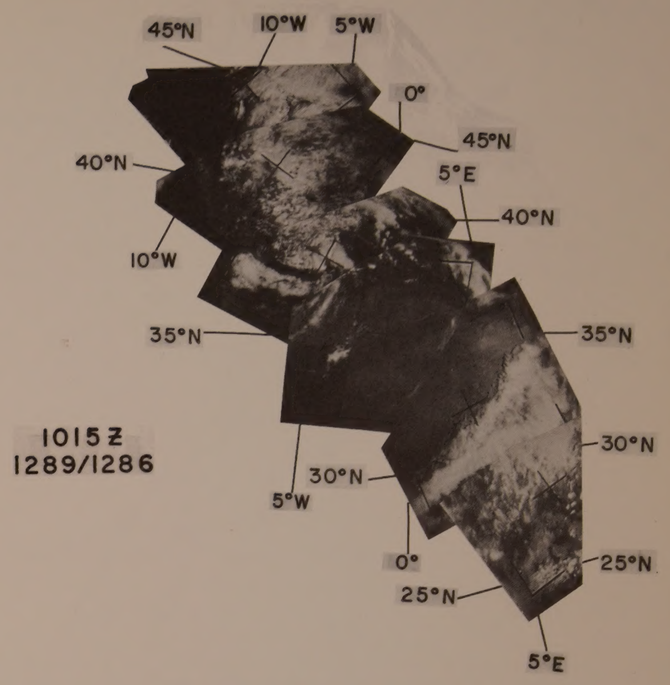


200 MB
13 SEPT. 1963
1200 GMT

SURFACE
14 SEPT. 1963
1200 GMT


INCREASE IN SEPTUM
SURFACE

1511Z
1290/1289



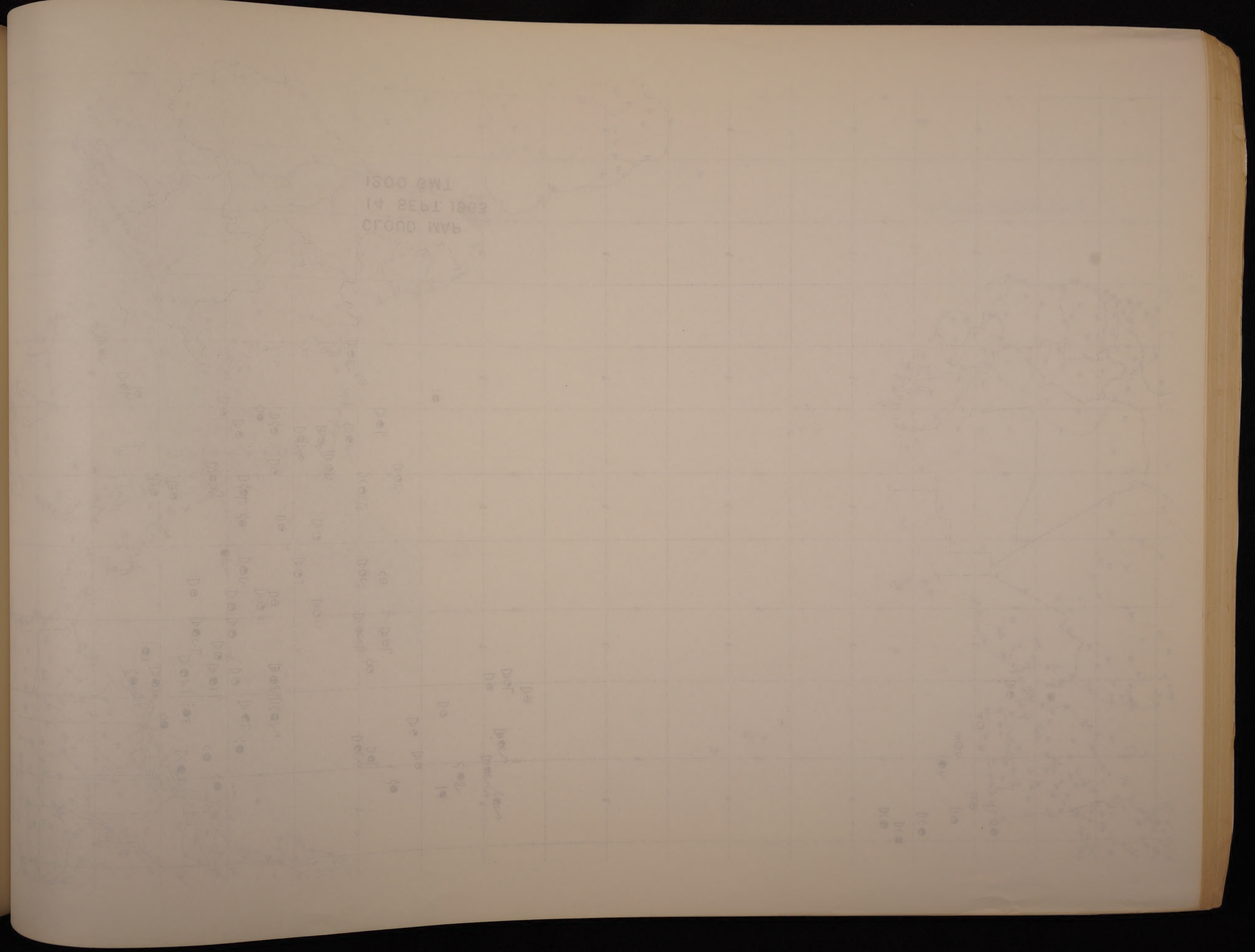
1015Z
1289/1286

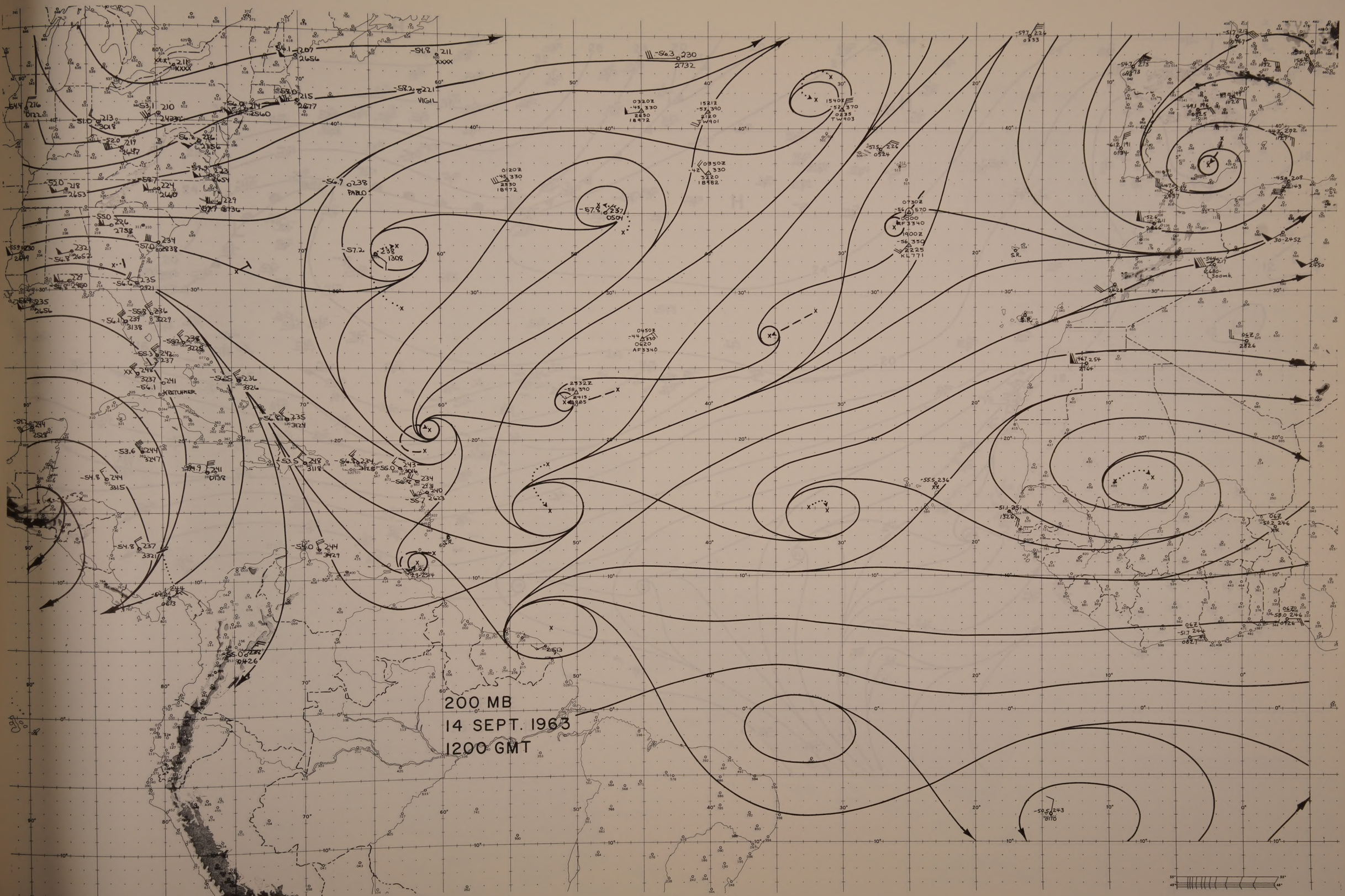
14 SEPTEMBER 1963

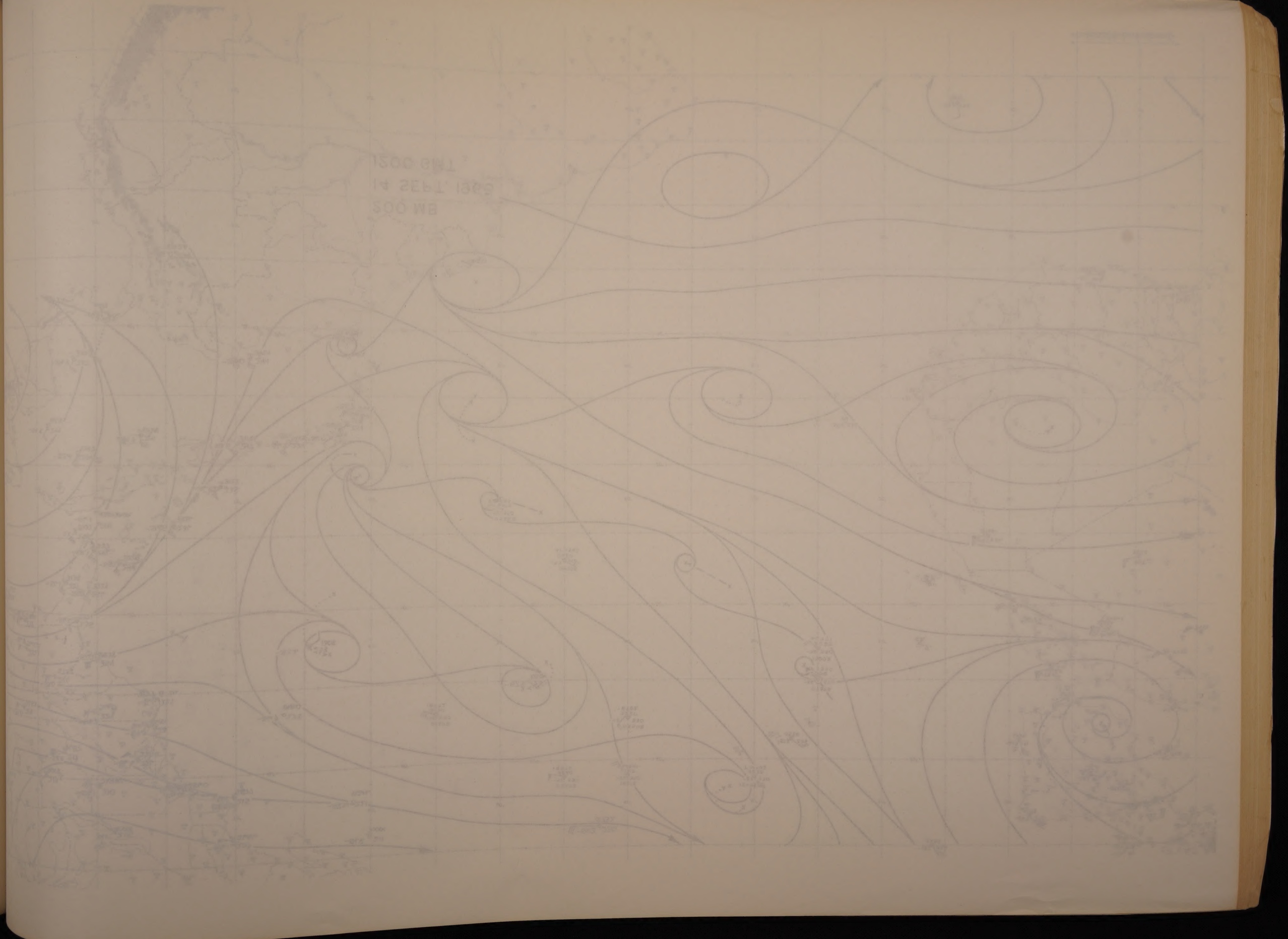
1701Z
5274/5271

14 SEPTEMBER 1963

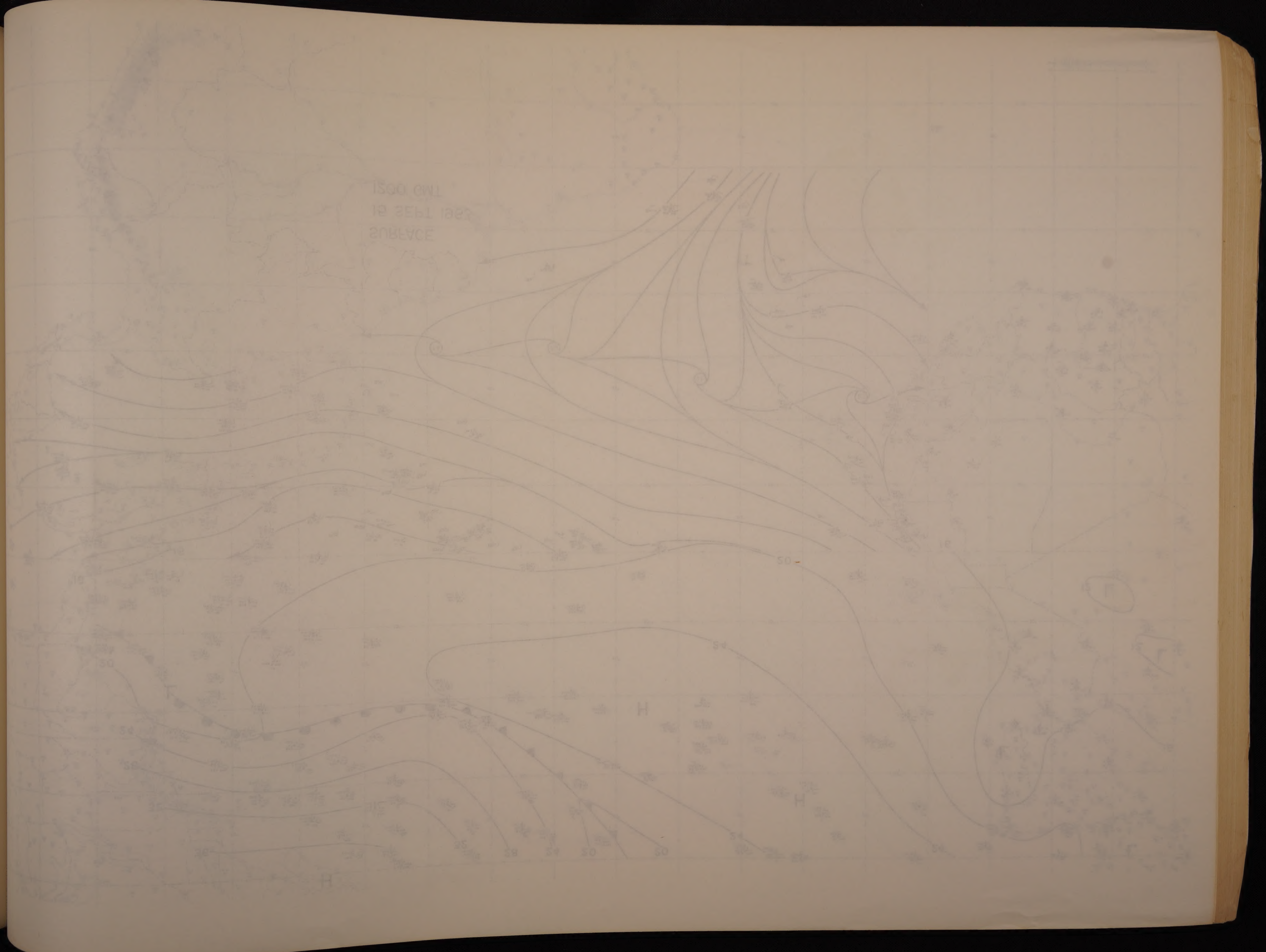
CLOUD MAP
14 SEPT. 1963
1200 GMT

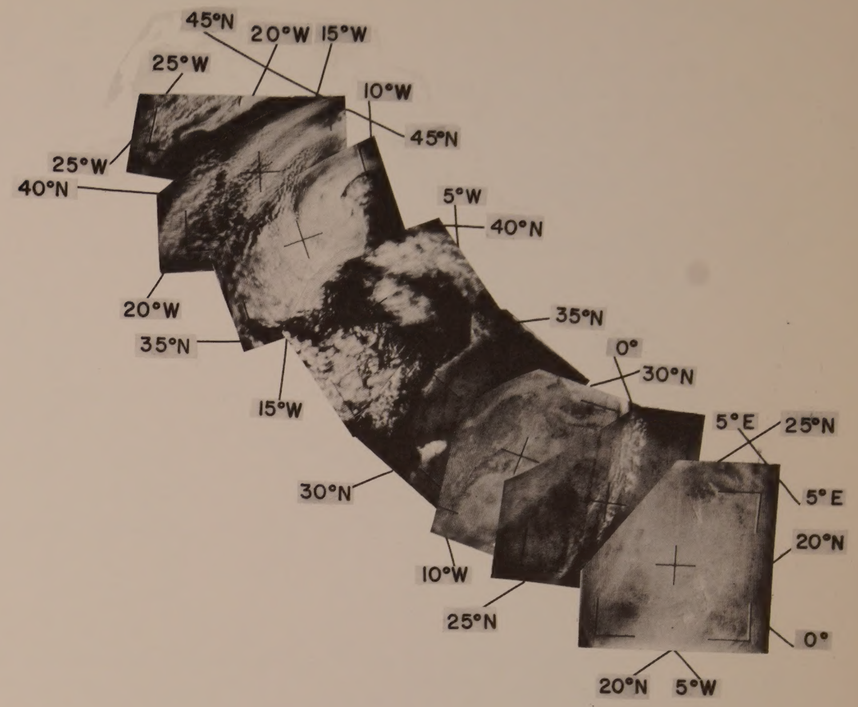


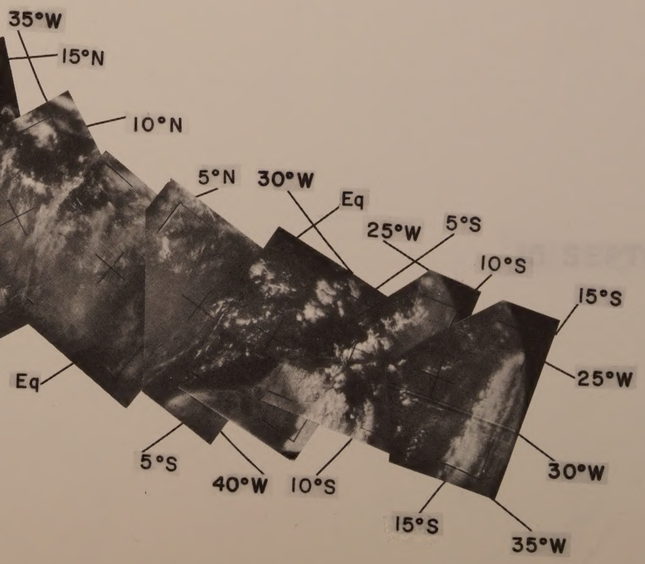

200 MB
14 SEPT. 1963
1200 GMT



SURFACE
15 SEPT. 1963
1200 GMT


ISOBARS
IN SEPT 1955
SURFACE
50
54
H
H
H
L
L
L
50
54
59
54
50
50

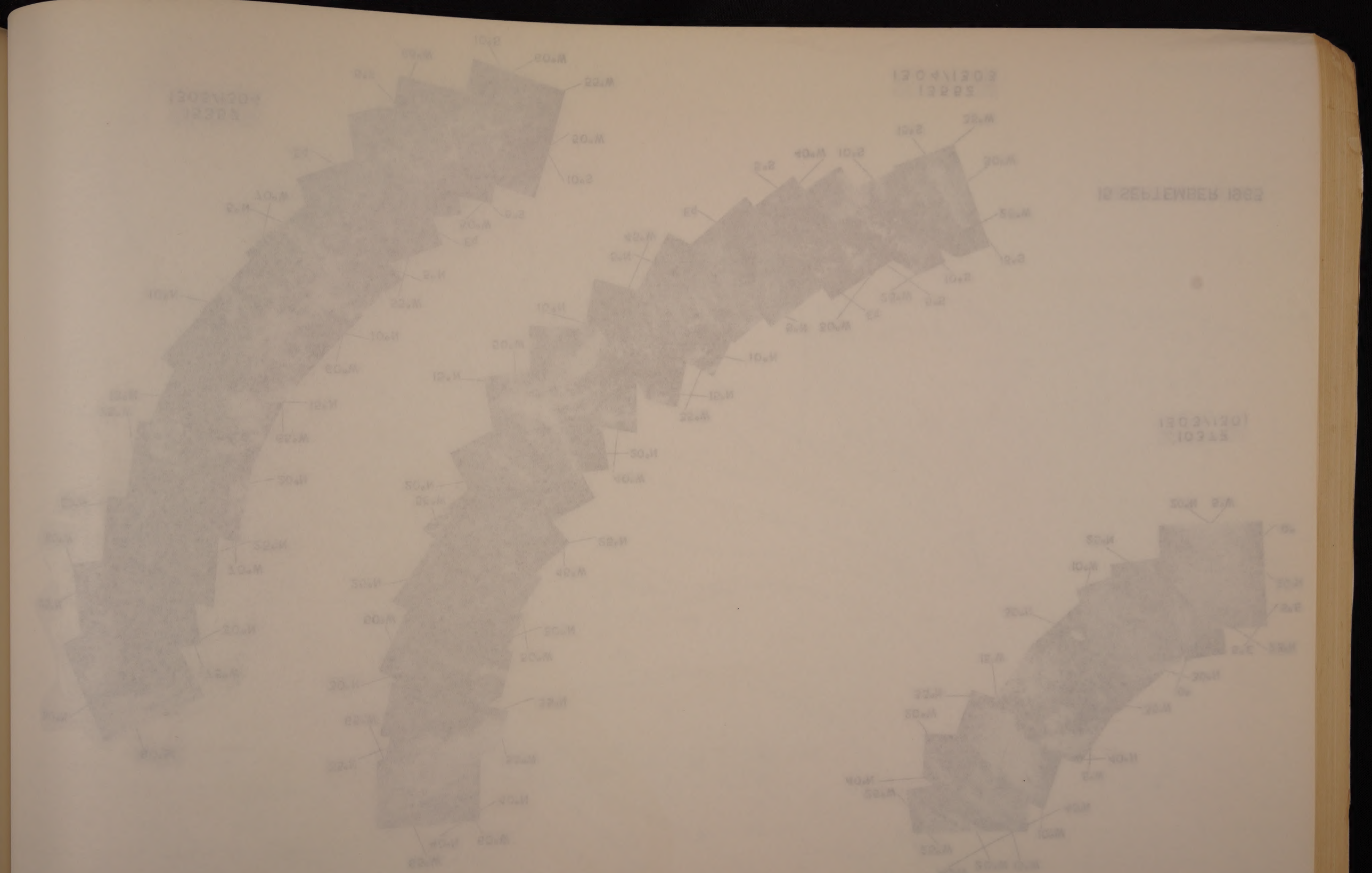


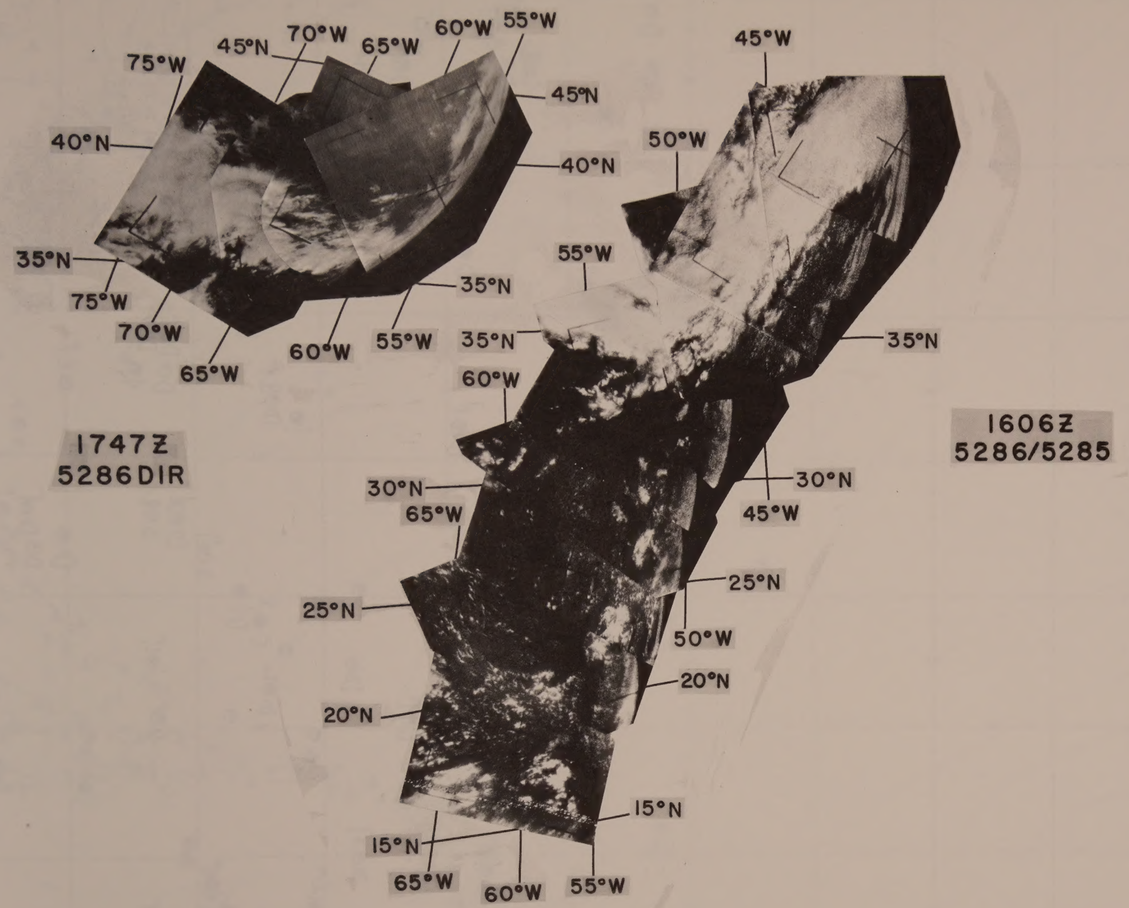


1037Z
1303/1301

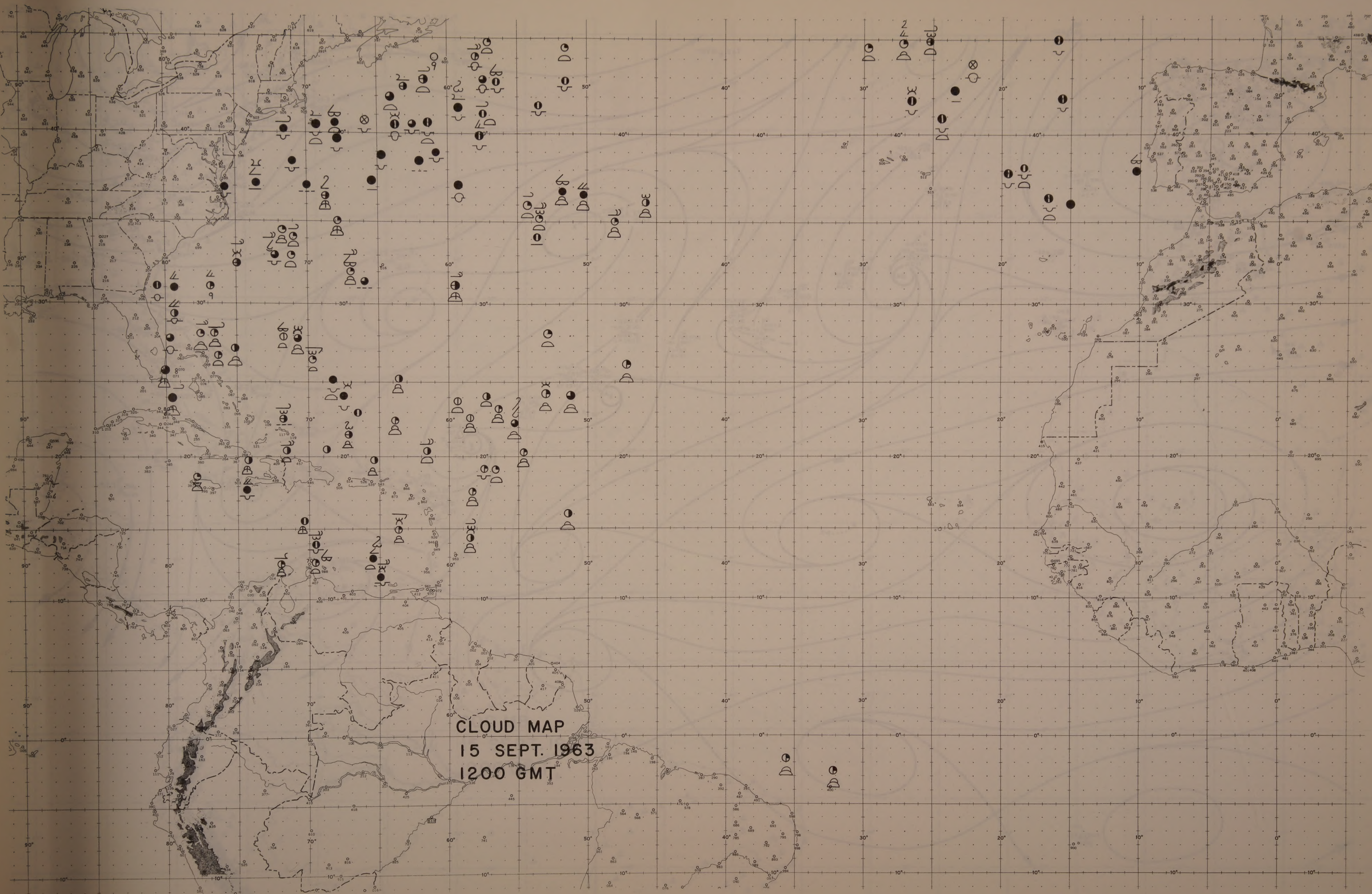
1355Z
1304/1303

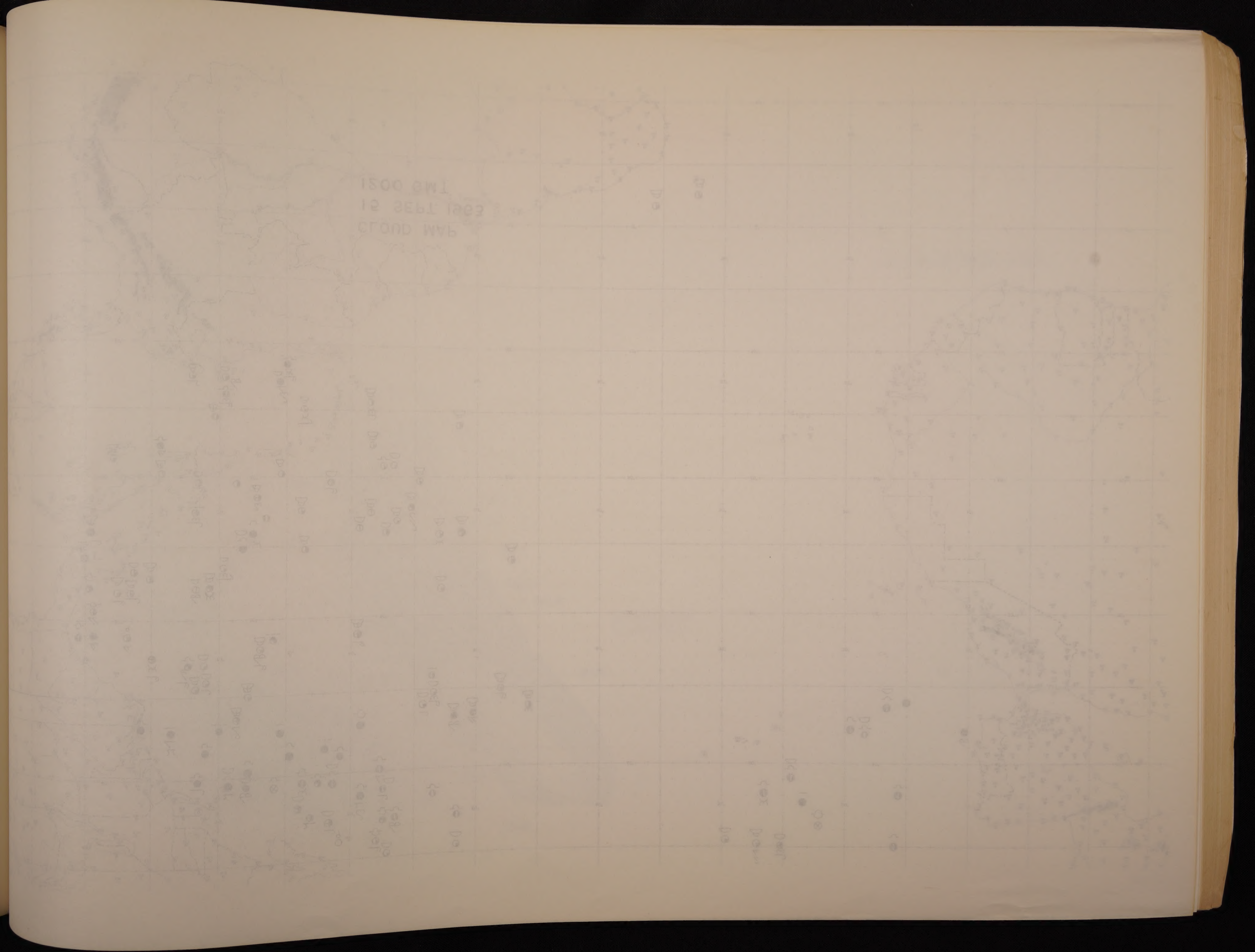
15 SEPTEMBER 1963



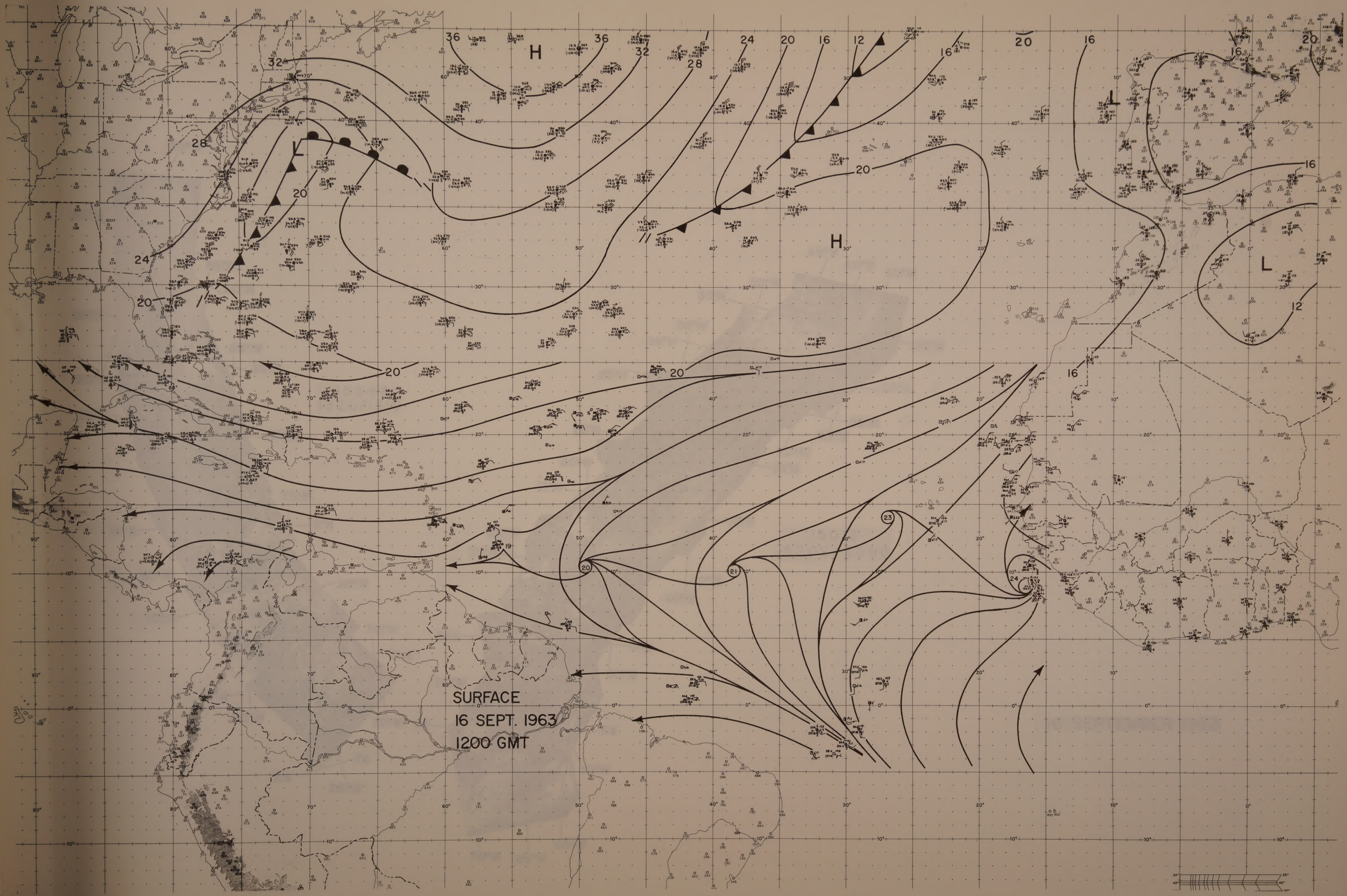


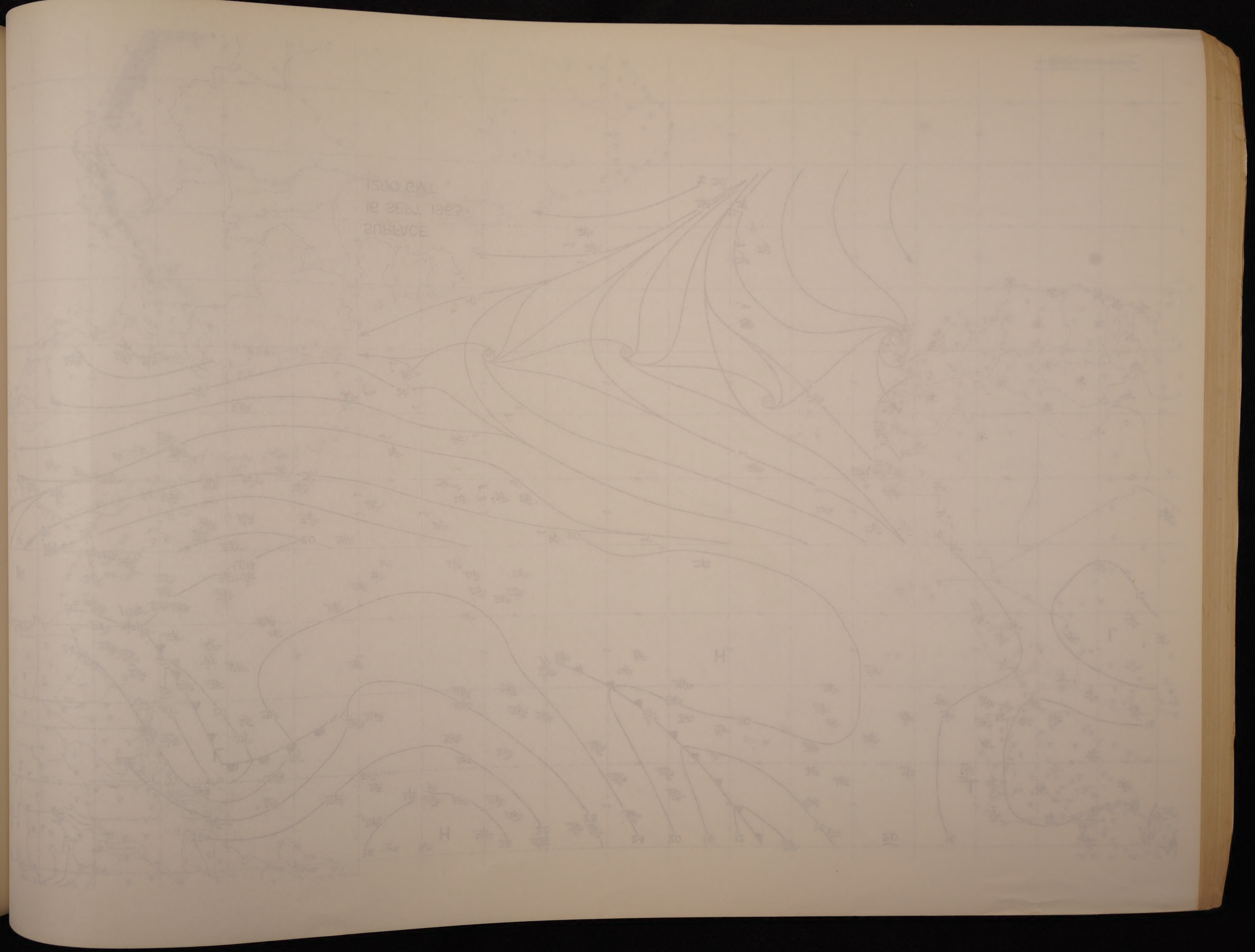
15 SEPTEMBER 1963

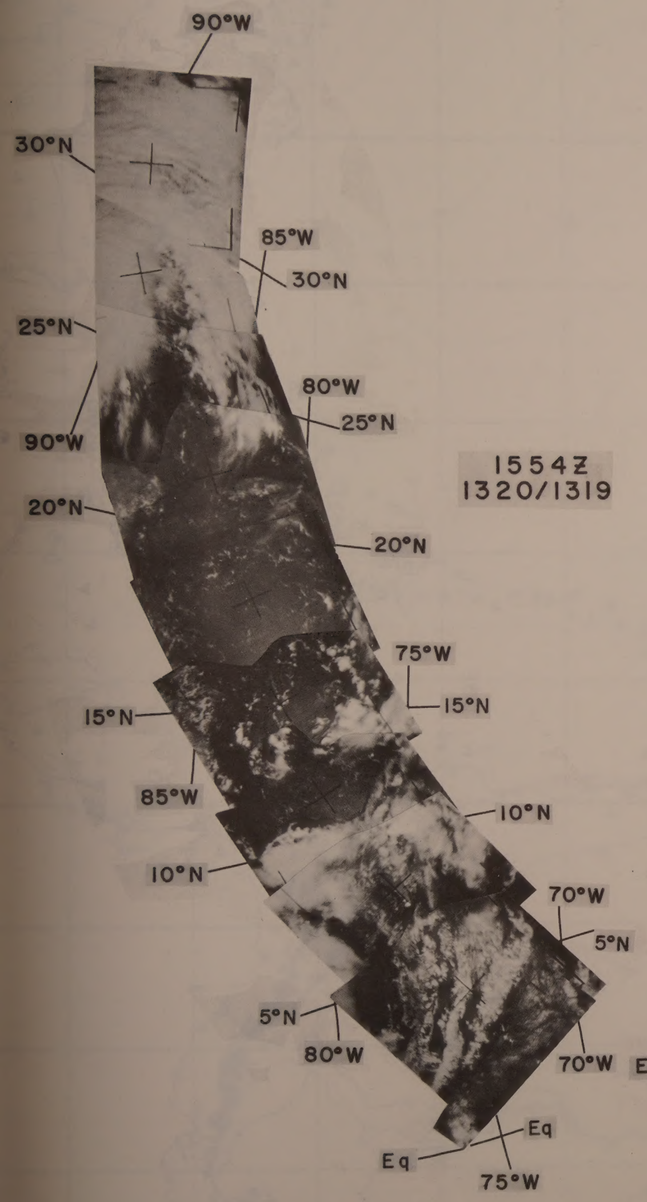

CLOUD MAP
15 SEPT. 1963
1200 GMT



200 MB
15 SEPT. 1963
1200 GMT


H
H
L
L
L
SURFACE
16 SEPT. 1963
1200 GMT

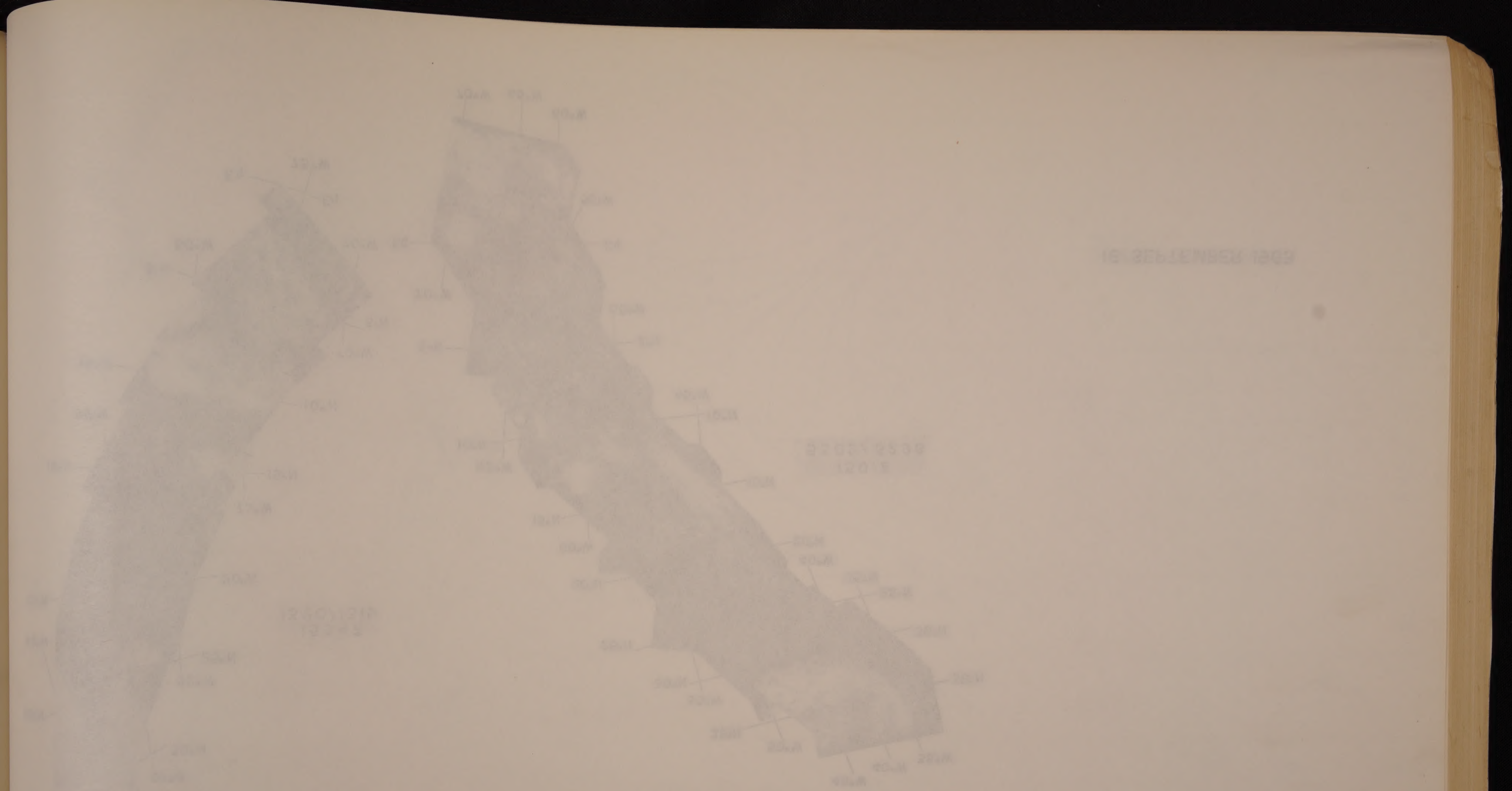




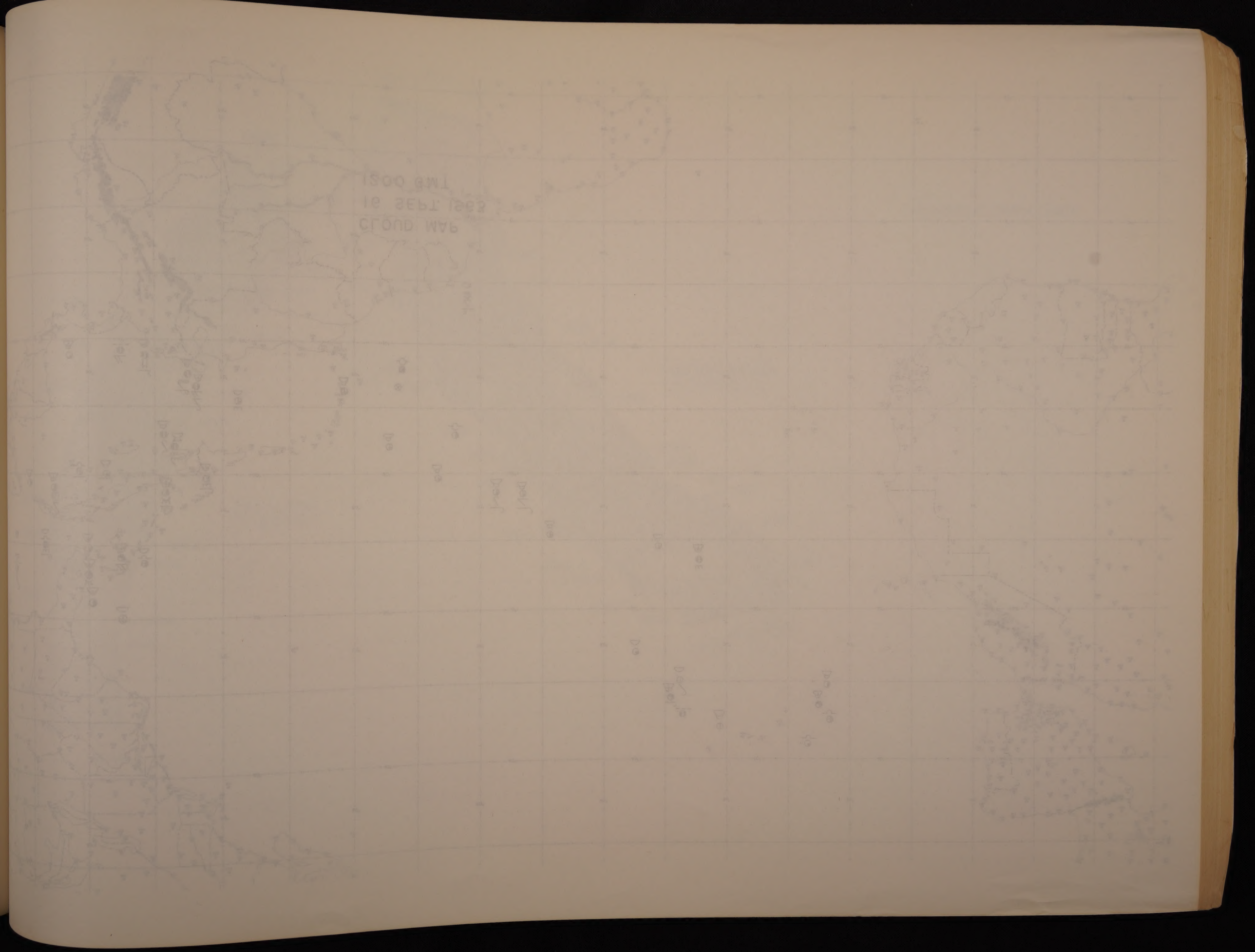
1554Z
1320/1319

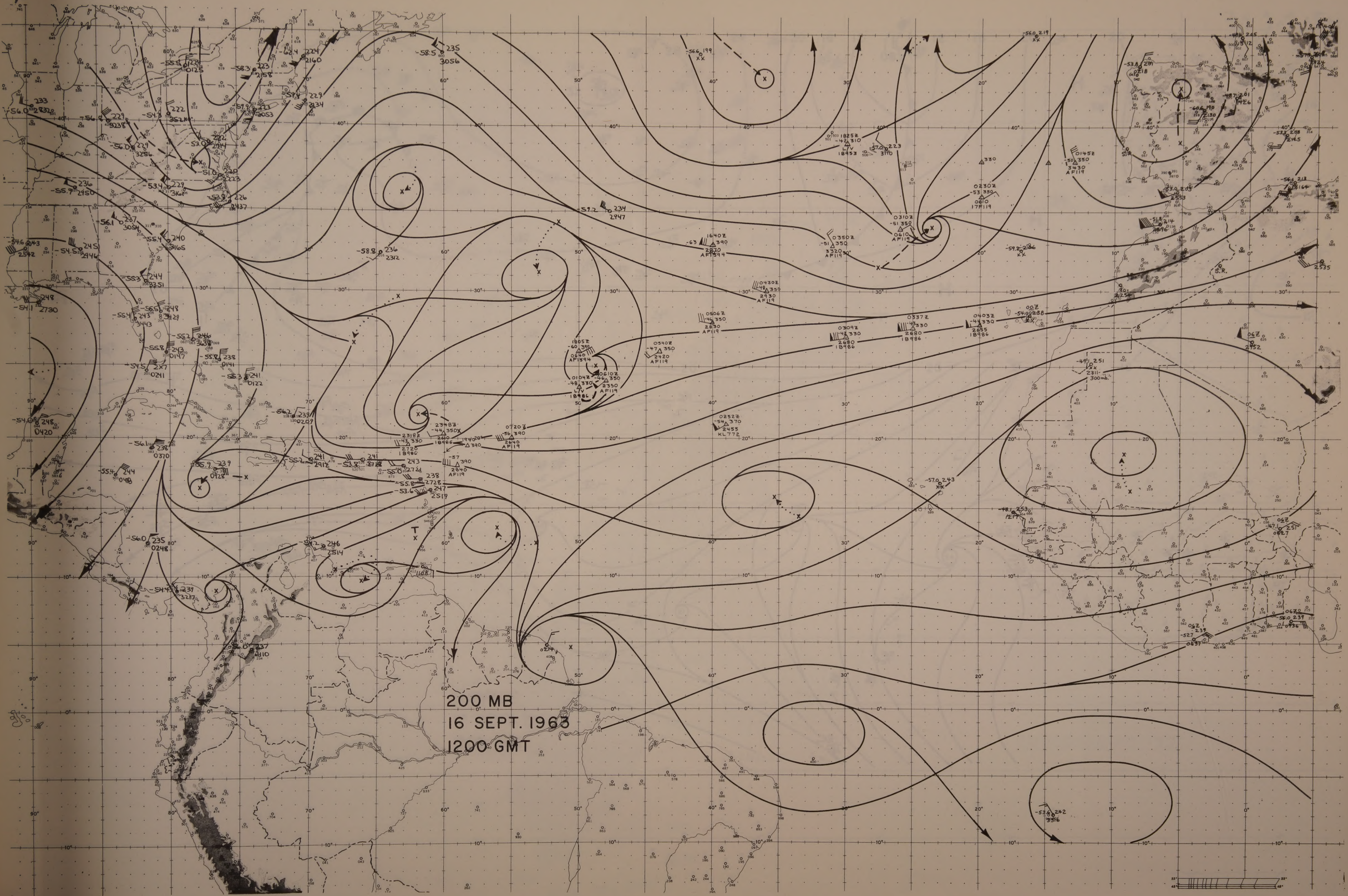
1501Z
5302/5298

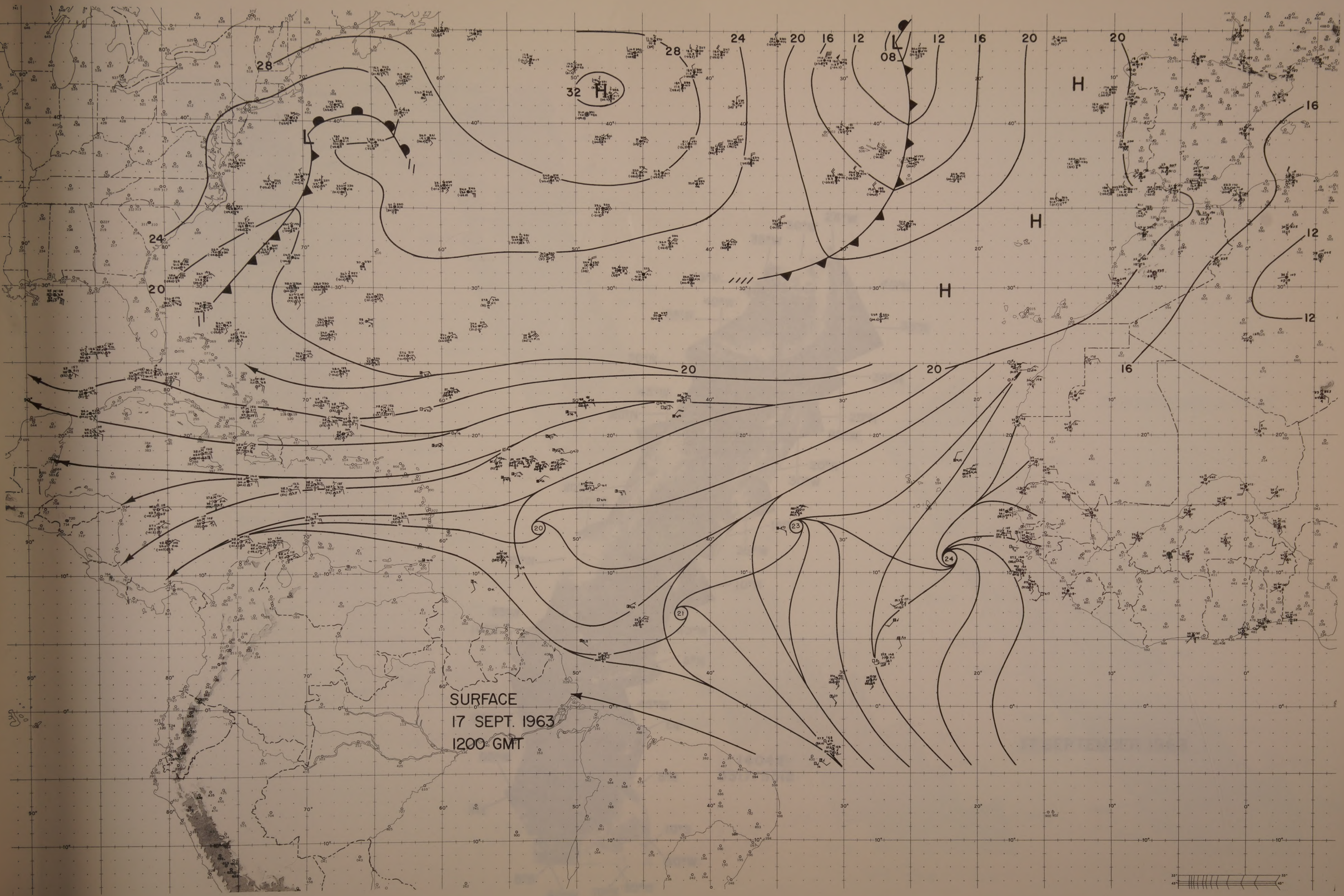
16 SEPTEMBER 1963



CLOUD MAP
16 SEPT. 1963
1200 GMT




200 MB
16 SEPT. 1963
1200 GMT


SURFACE
17 SEPT. 1963
1200 GMT

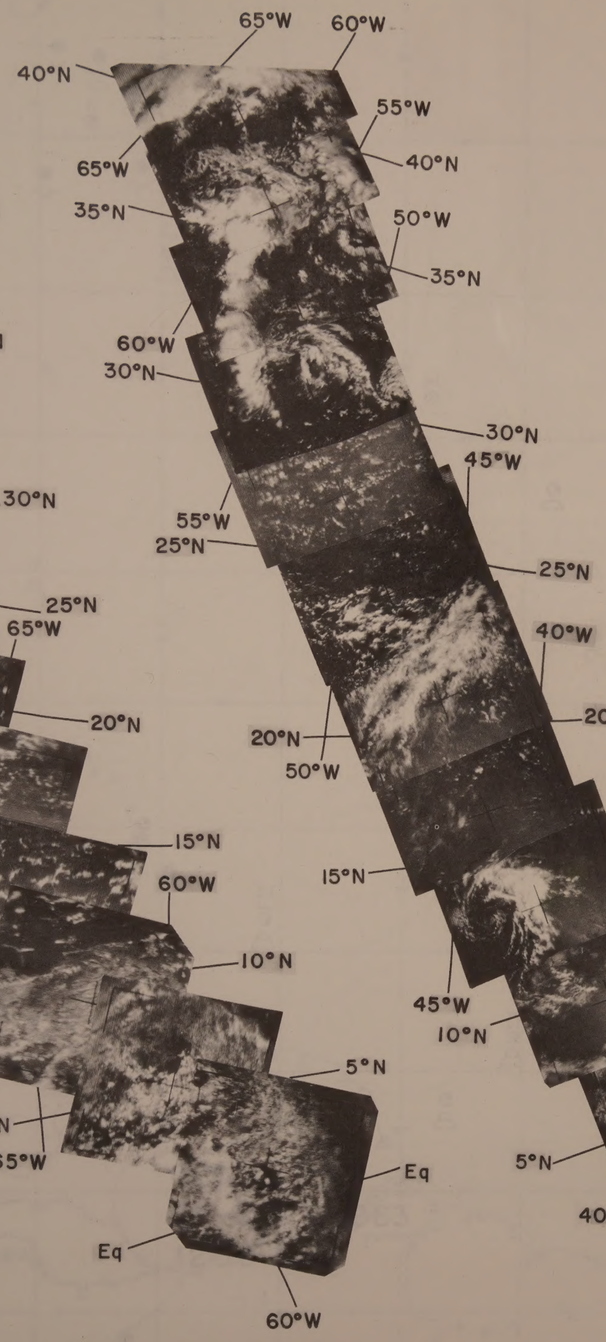
ISOGONAL
17 SEPT 1963
SURFACE

14042
5317/5312

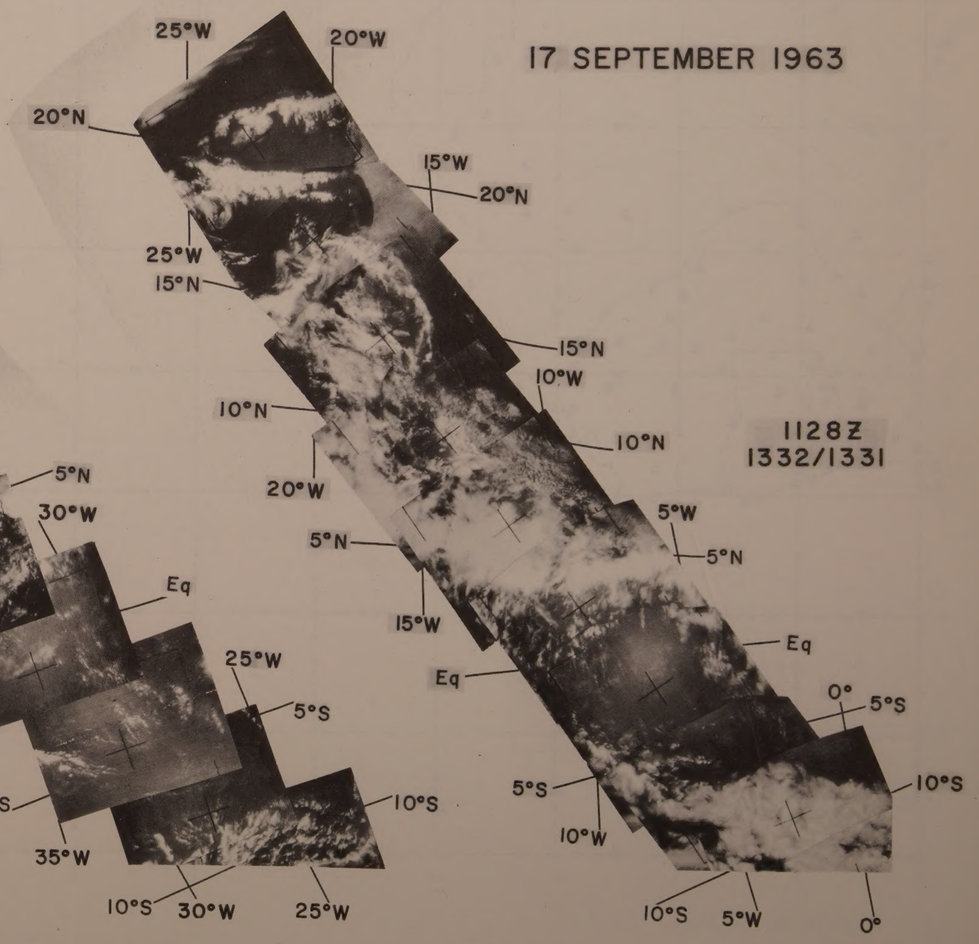
17 SEPTEMBER 1963

17 SEPTEMBER 1963

1433Z
1334/1333

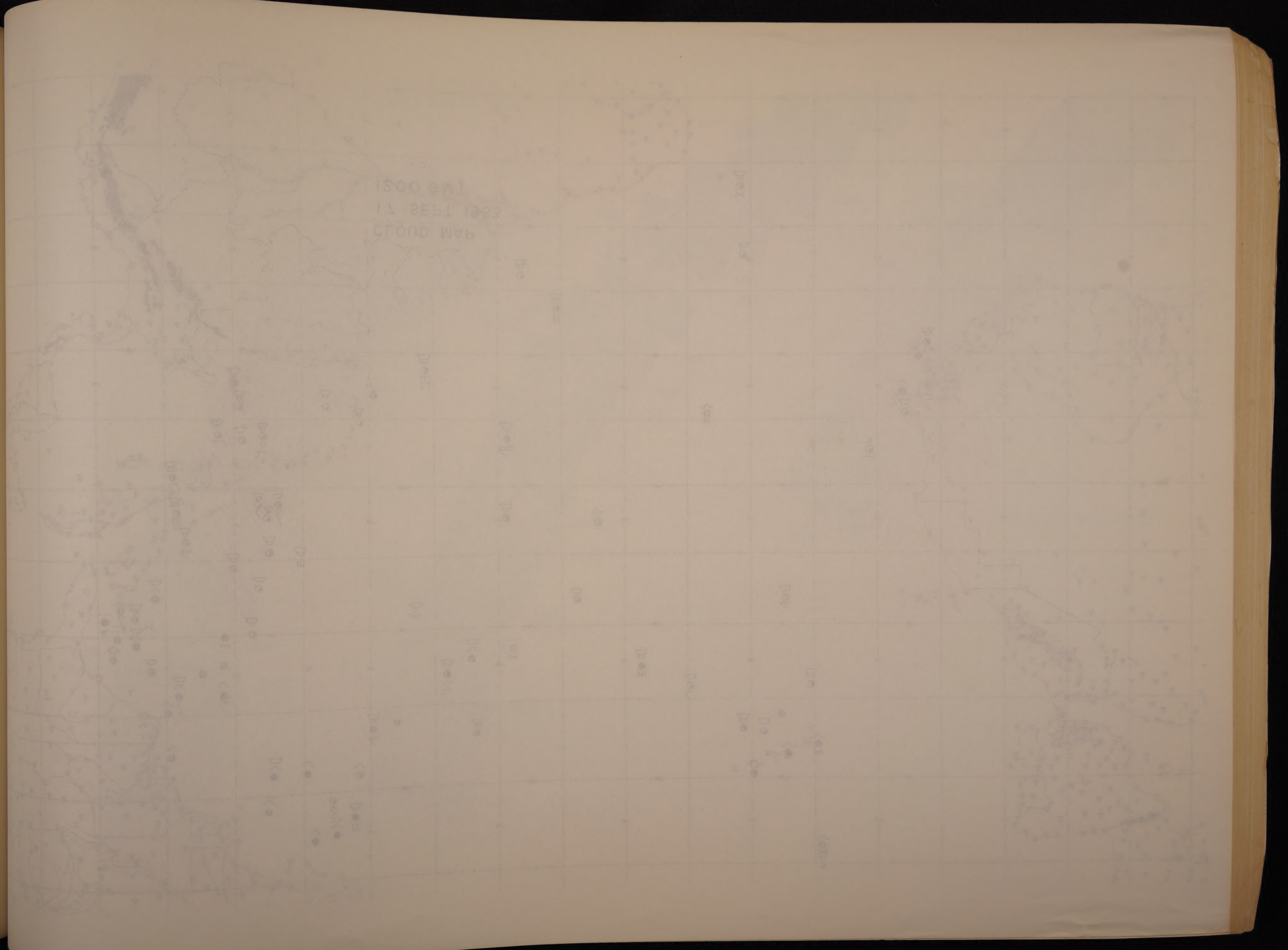


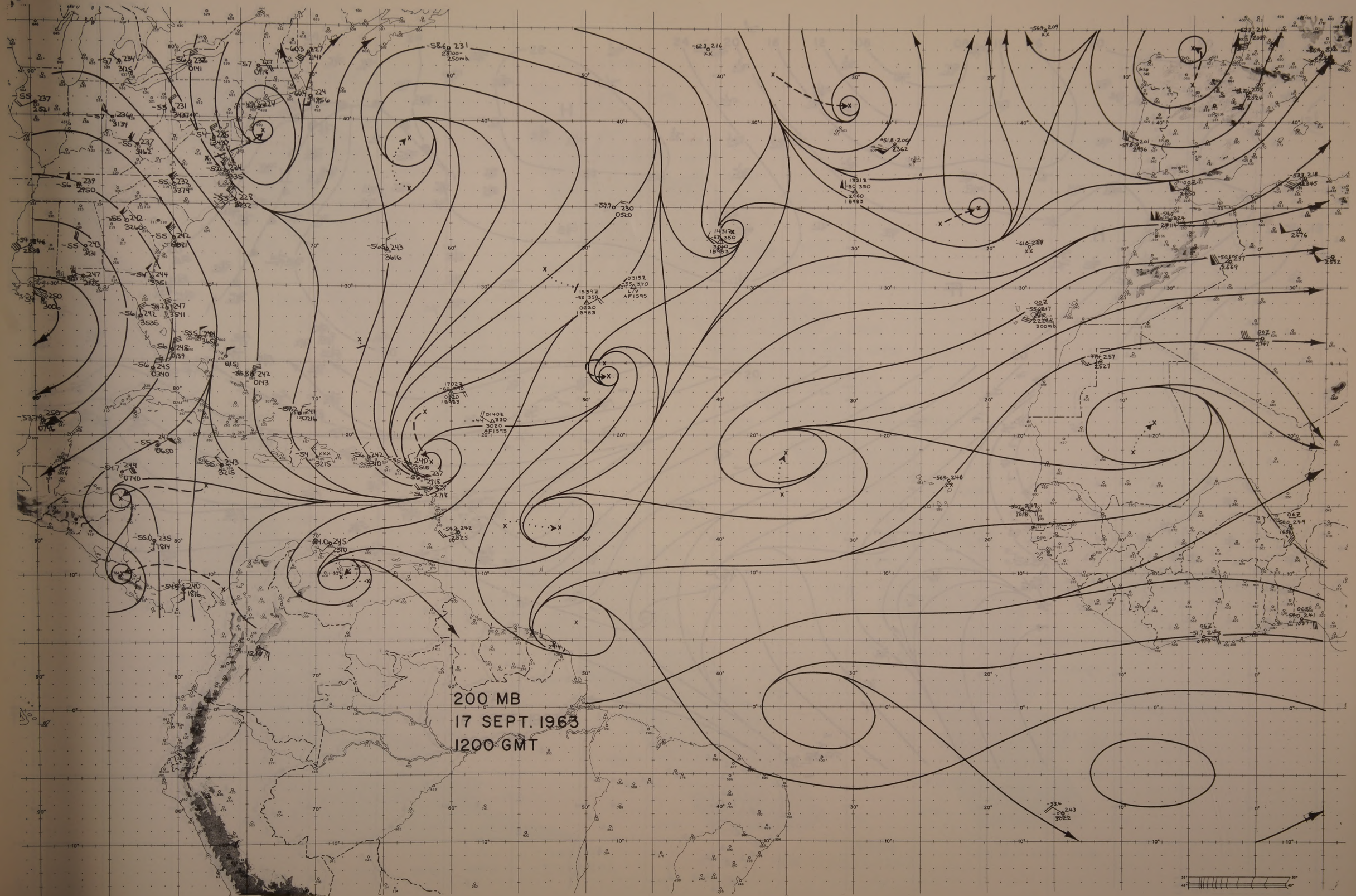
1300Z
1333/1332



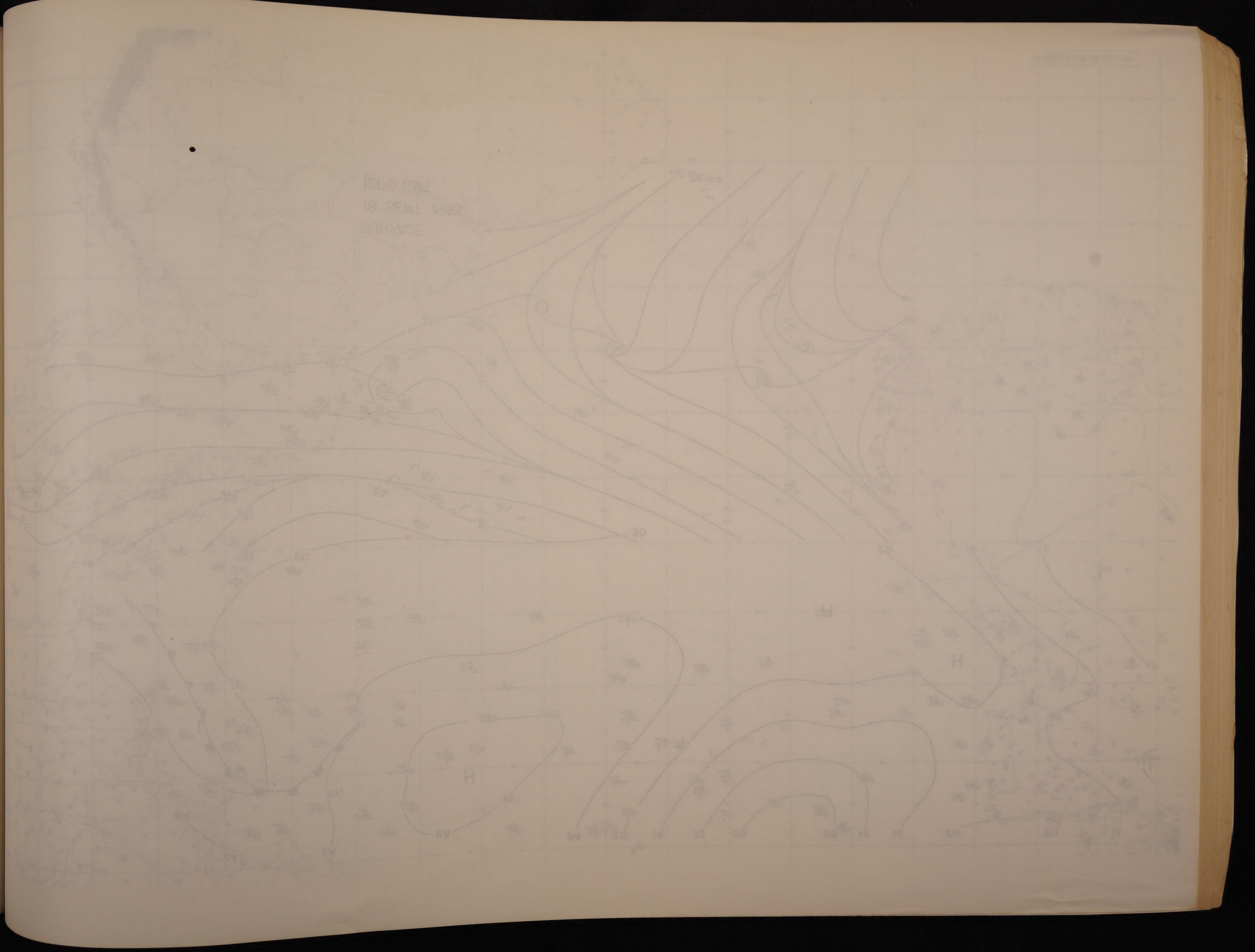
1128Z
1332/1331

CLOUD MAP
17 SEPT. 1963
1200 GMT




200 MB
17 SEPT. 1963
1200 GMT

SURFACE
18 SEPT. 1963
1200 GMT

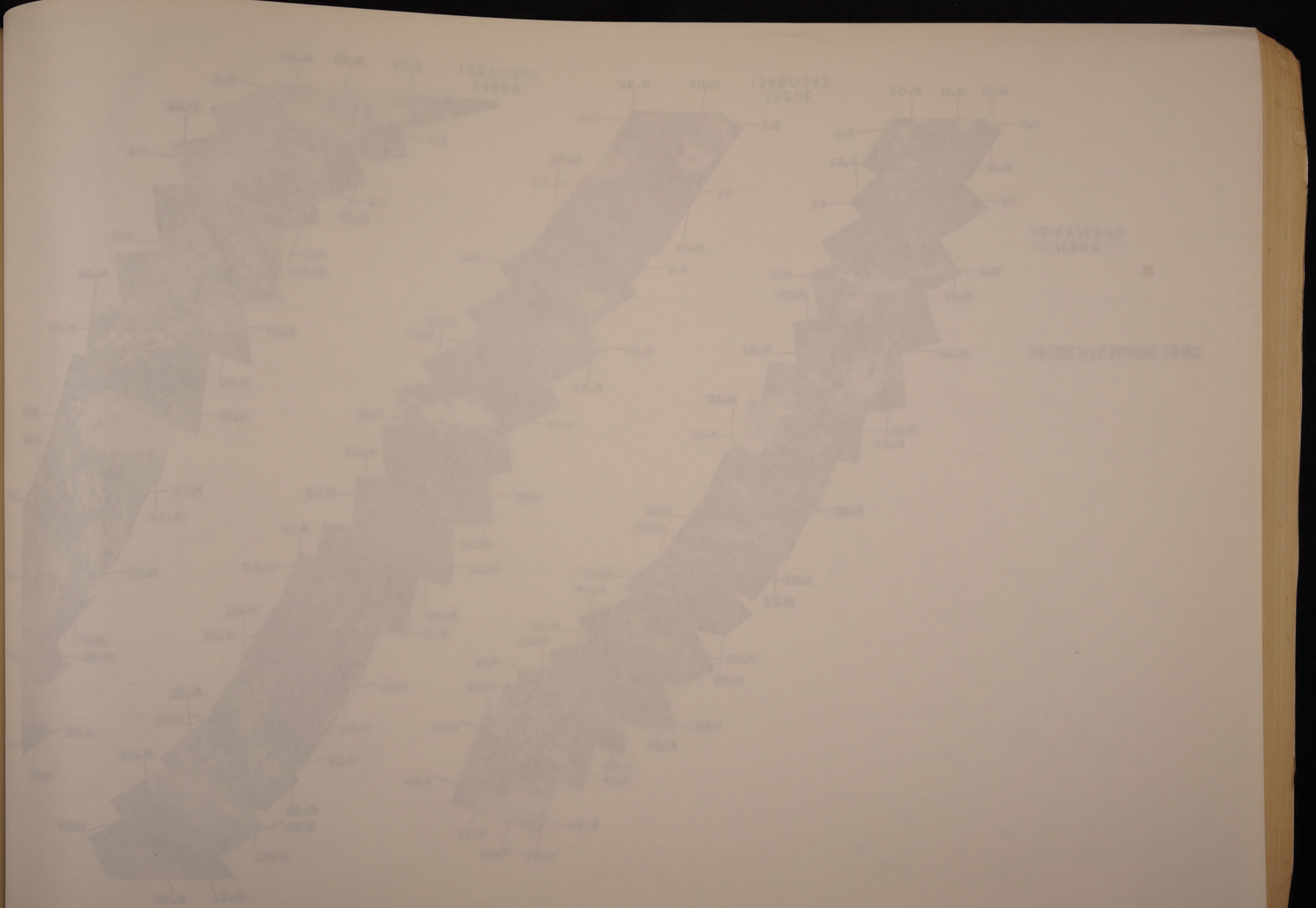

H
H
H
50
50
50

18 SEPTEMBER 1963

1139Z
1347/1346

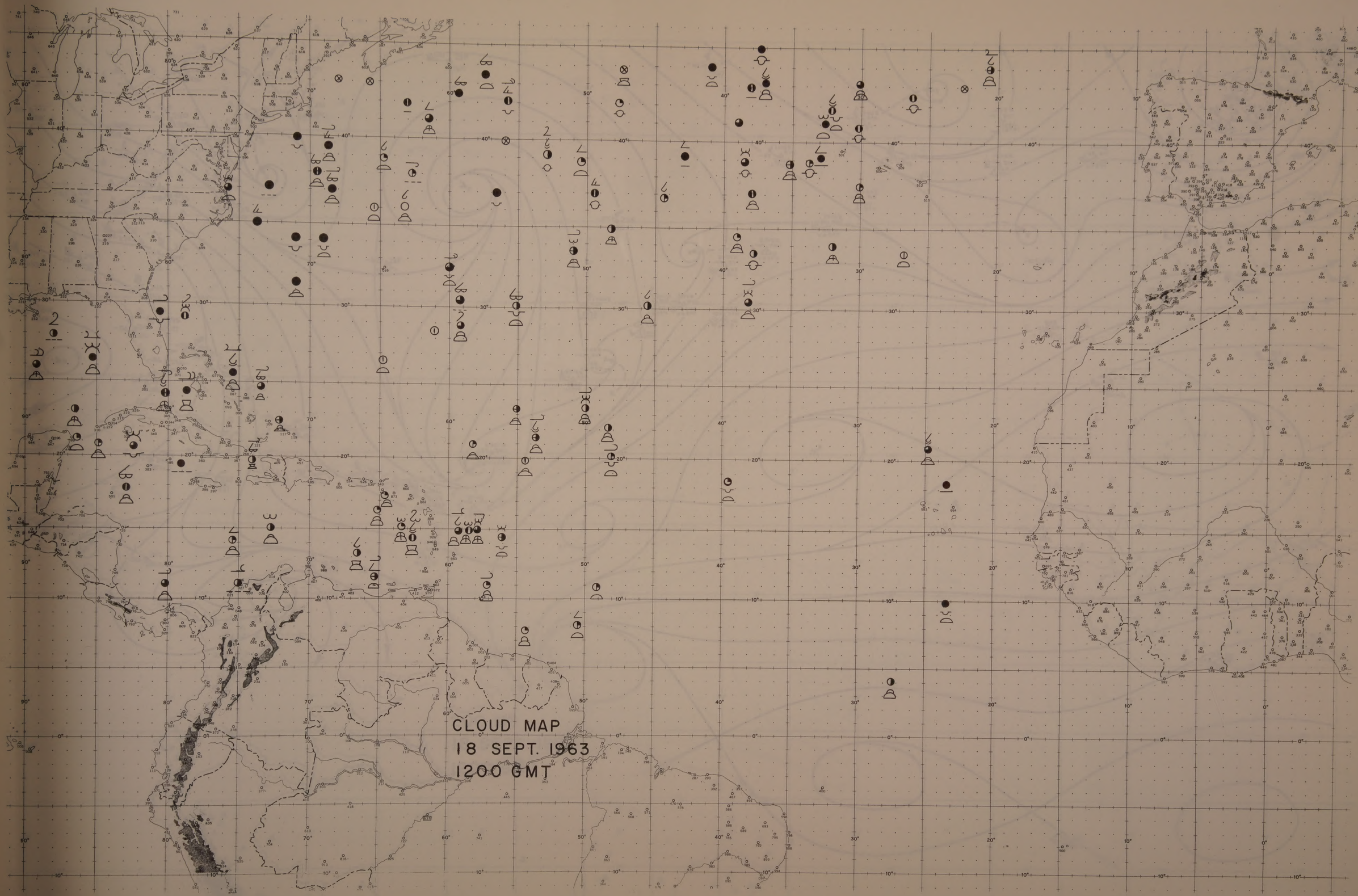
1458Z
1357/1348

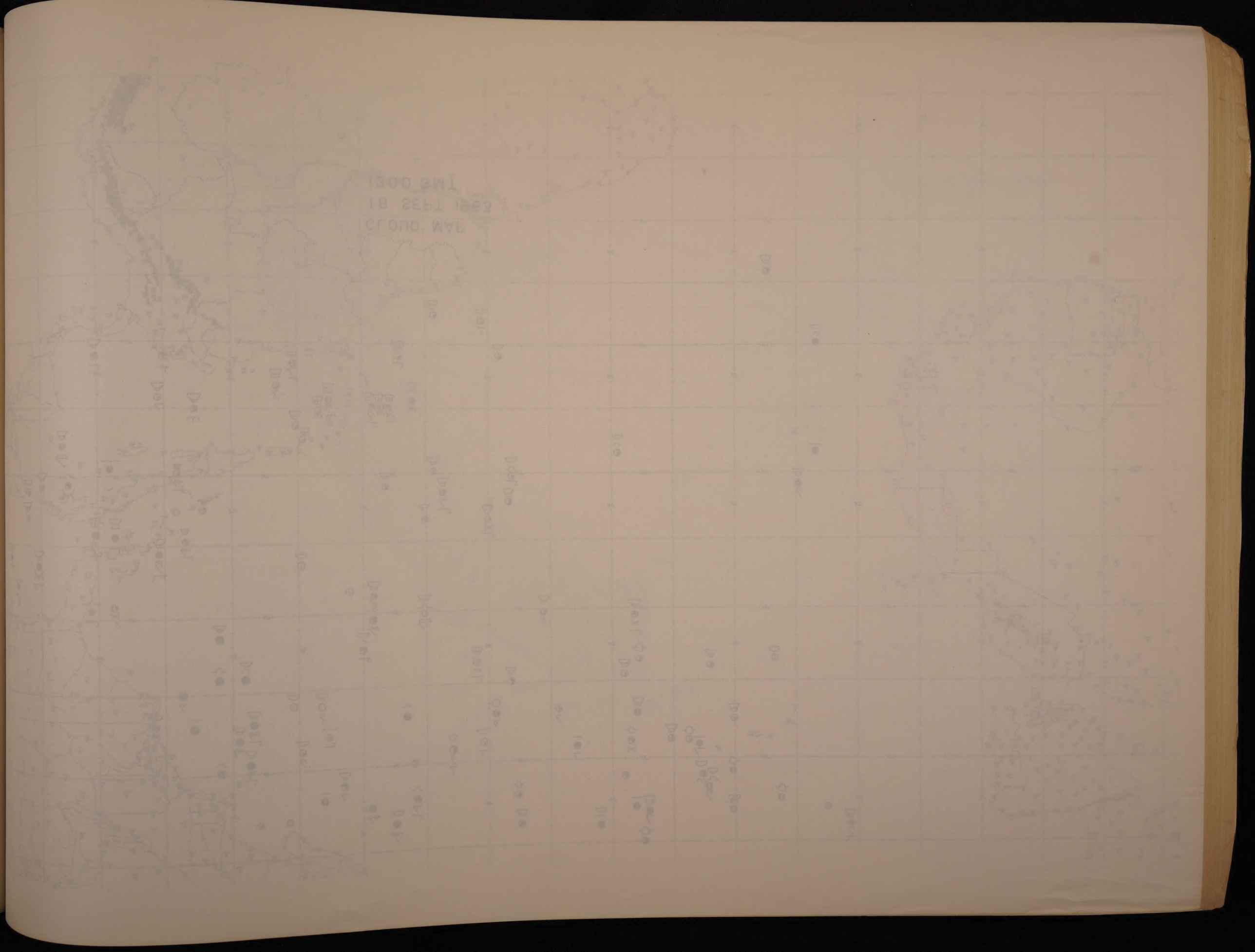
1320Z
1348/1347

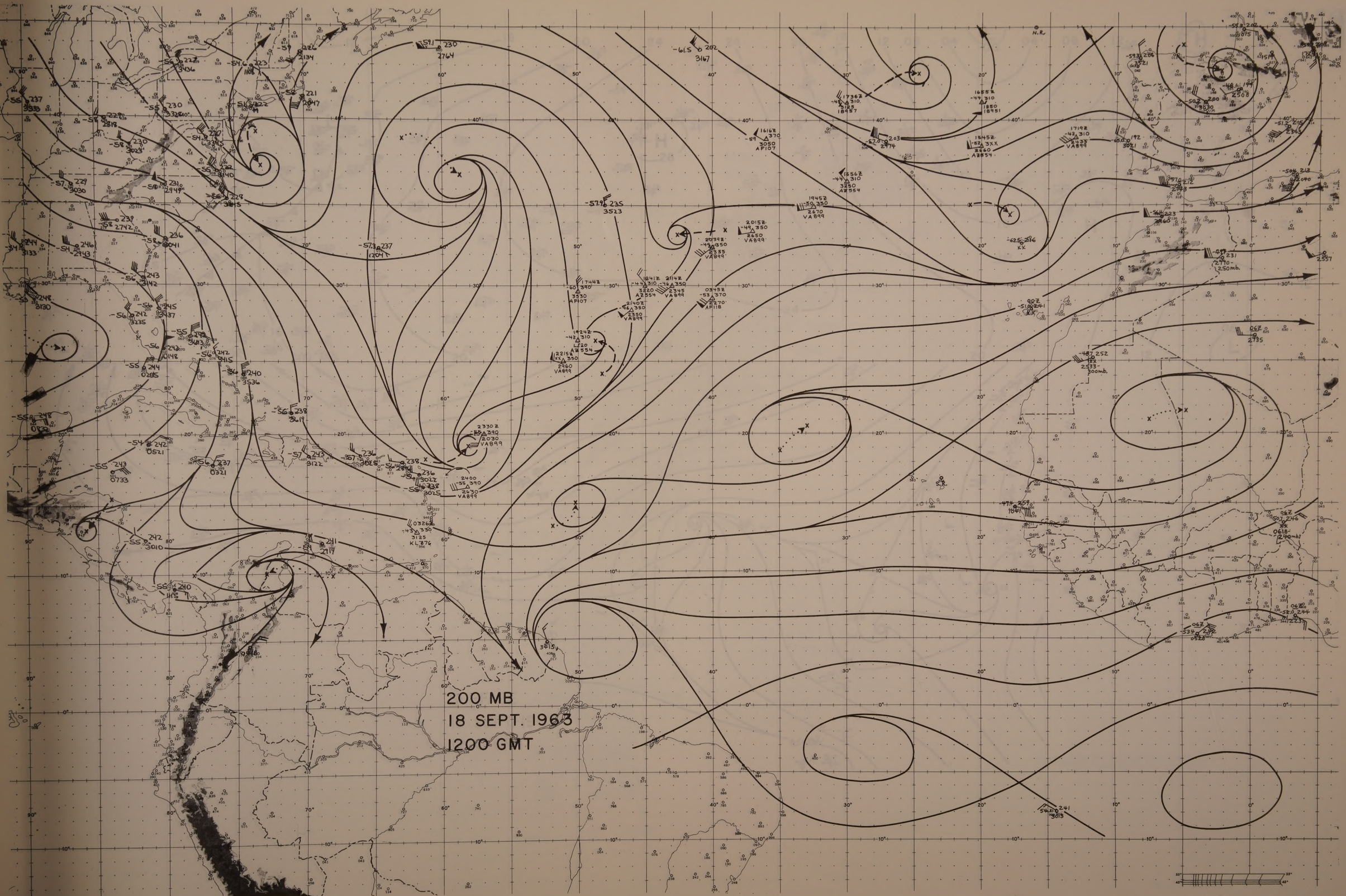


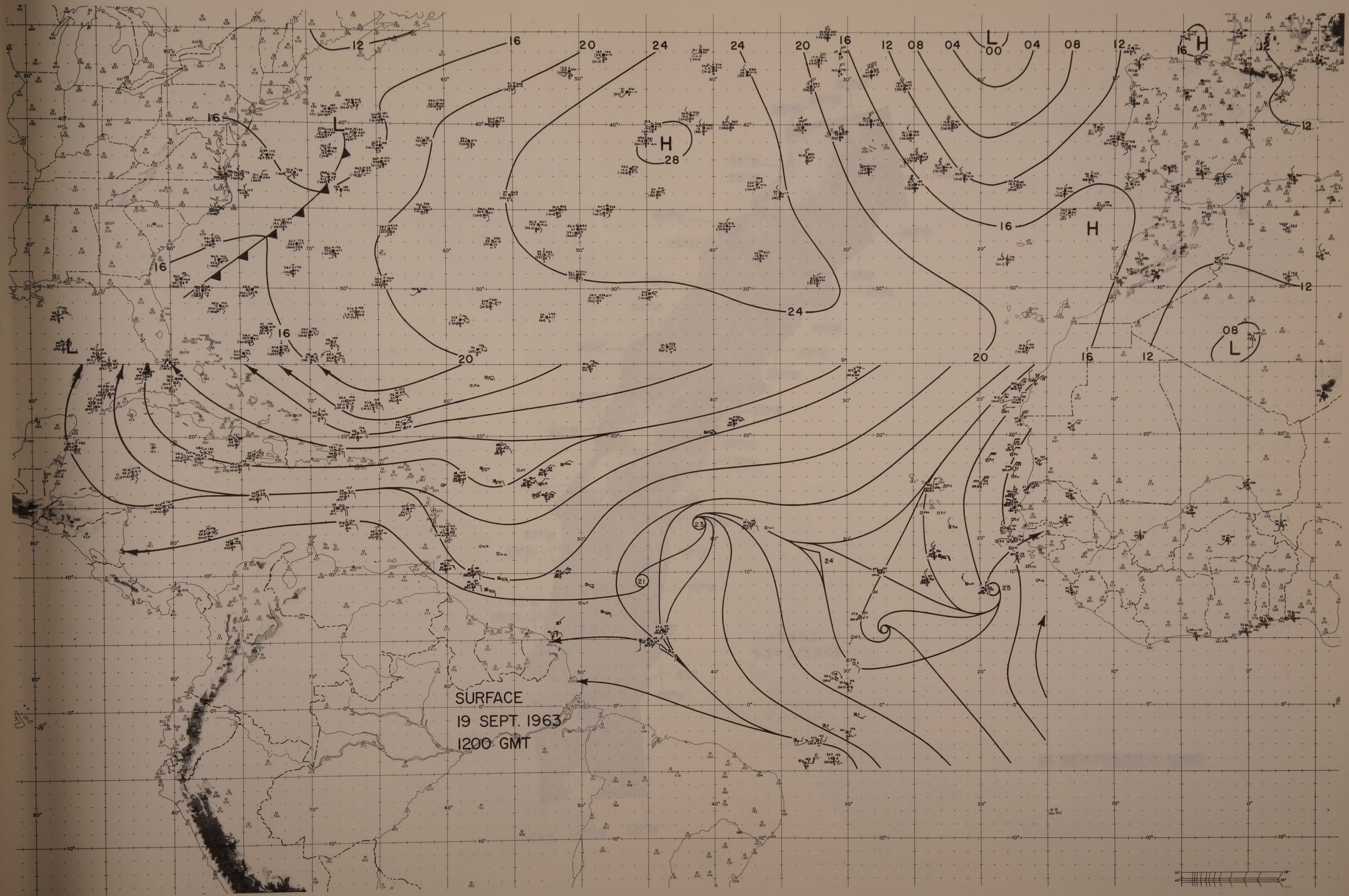
1448Z
5333/5328

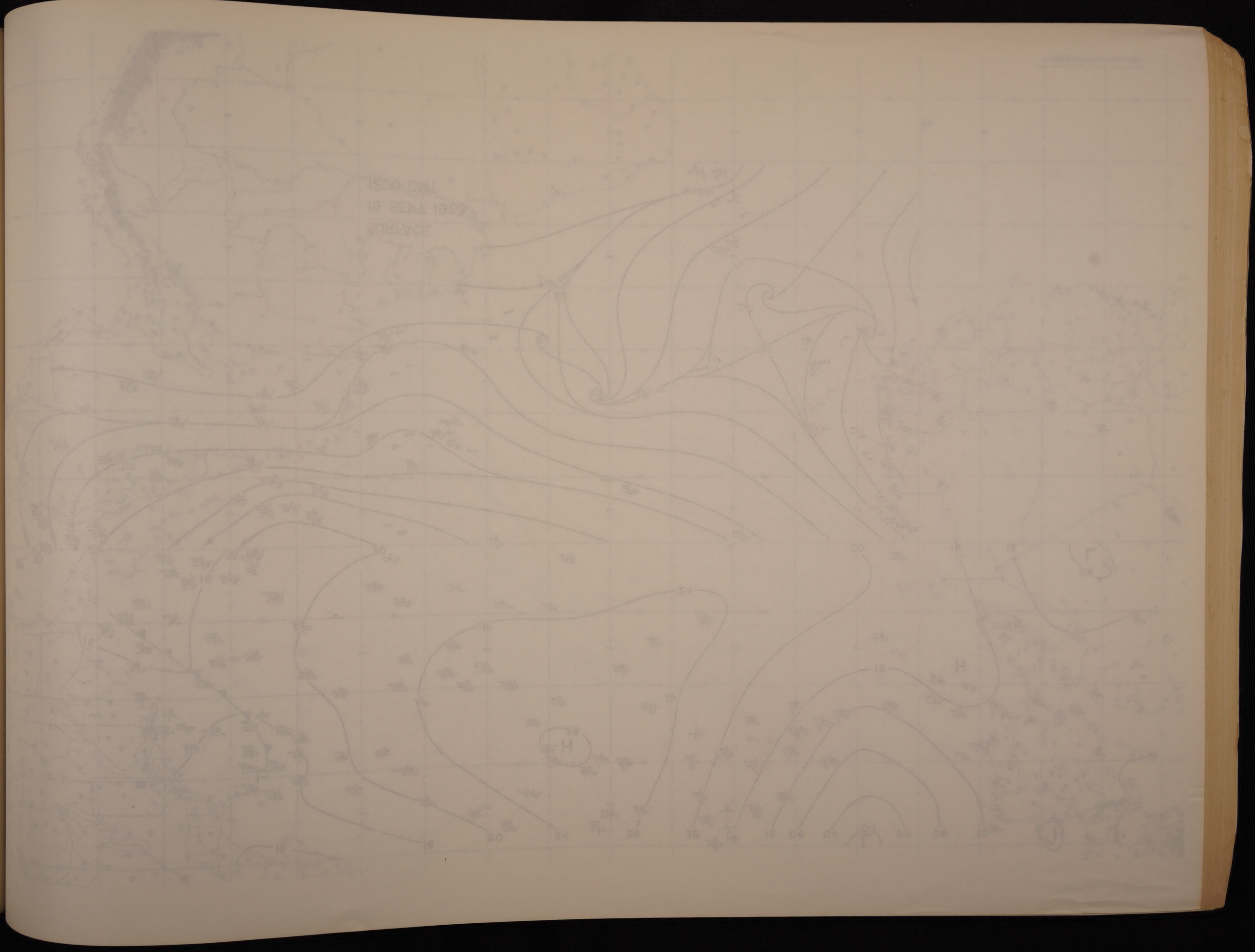
18 SEPTEMBER 1963


CLOUD MAP
18 SEPT. 1963
1200 GMT




200 MB
18 SEPT. 1963
1200 GMT


SURFACE
19 SEPT. 1963
1200 GMT

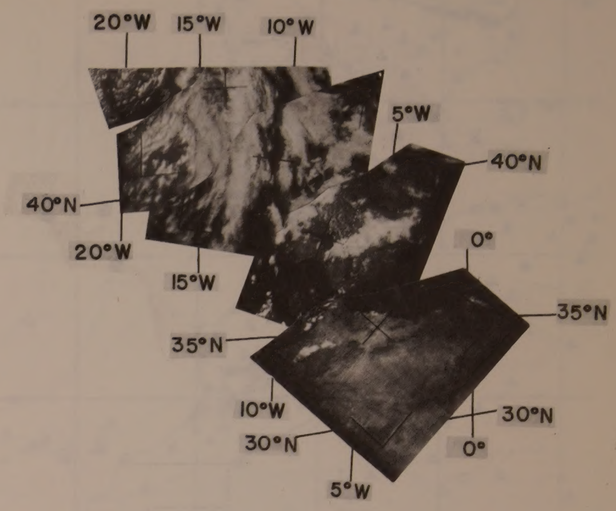

H
H
H
L
L
50
50
50

1350Z
5346/5342

19 SEPTEMBER 1963

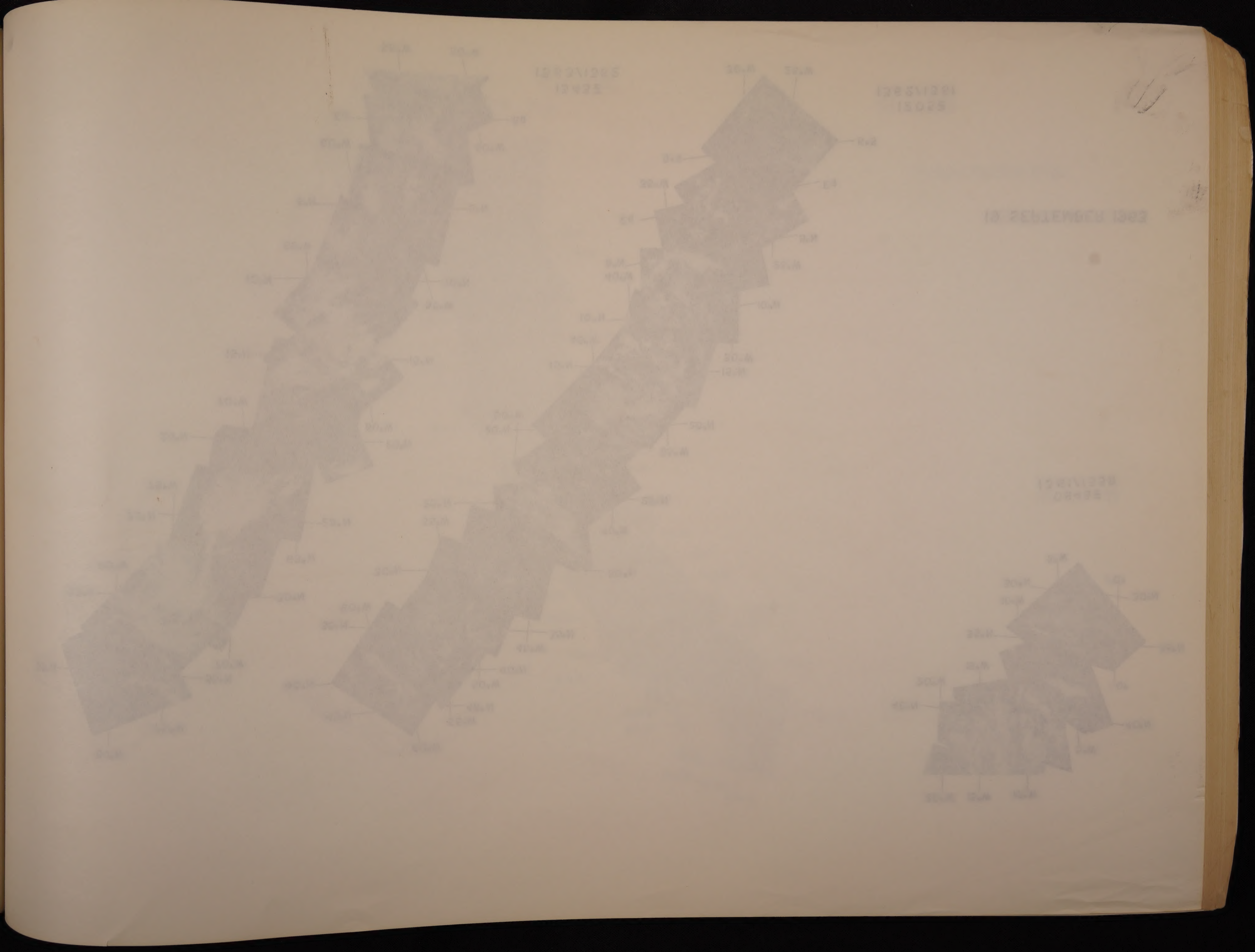
1343Z
1363/1362

1205Z
1362/1361

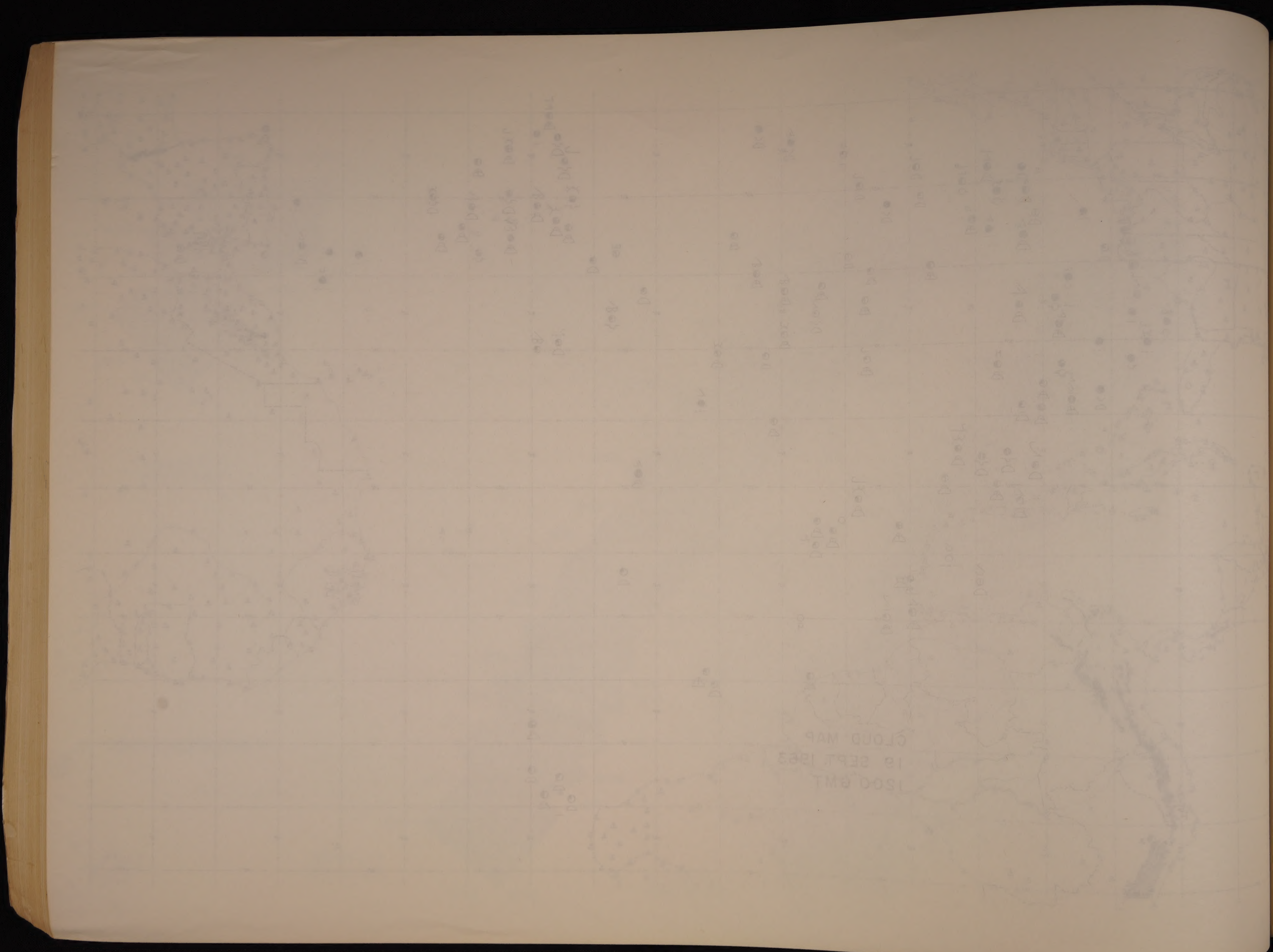


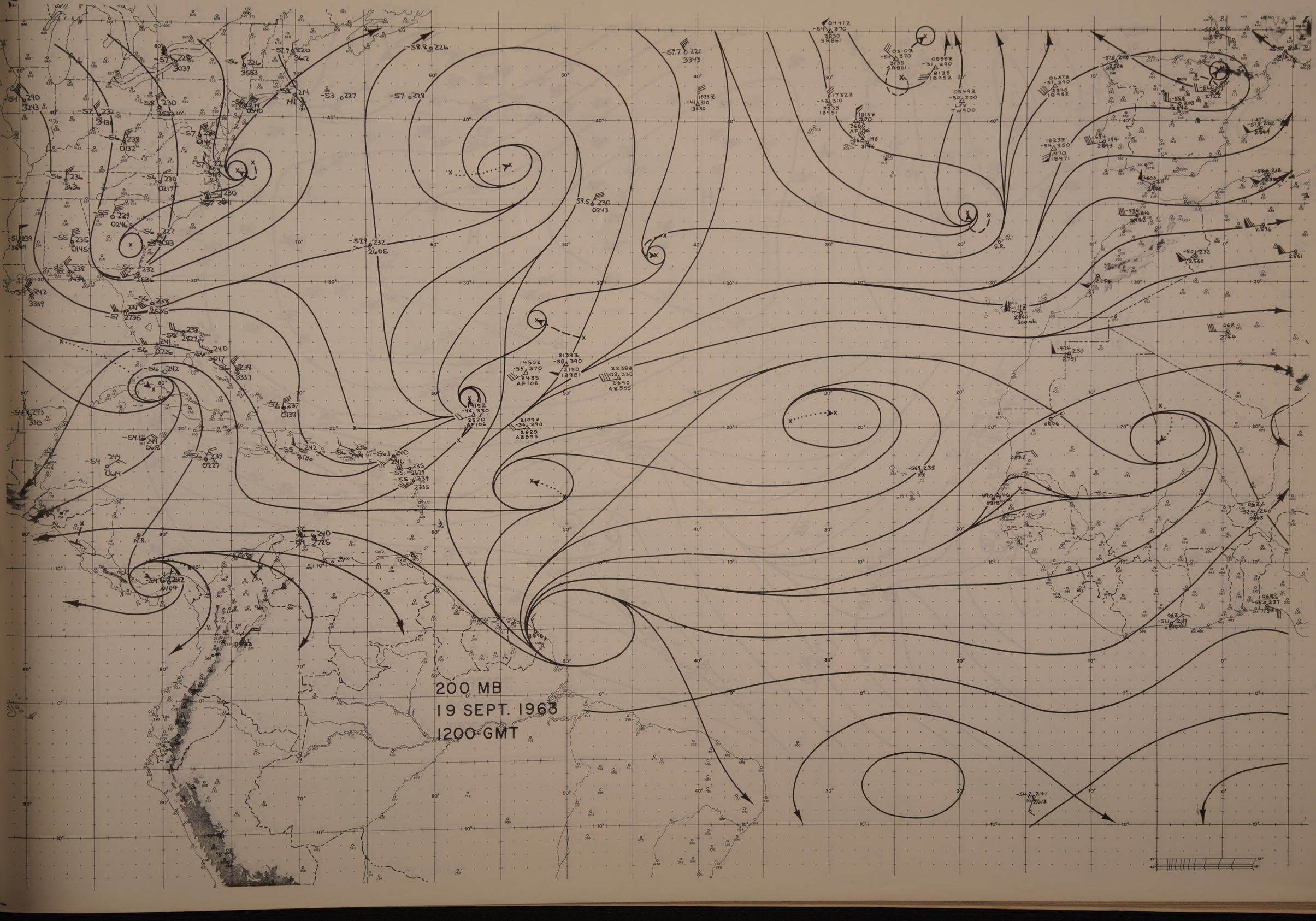
0843Z
1361/1359

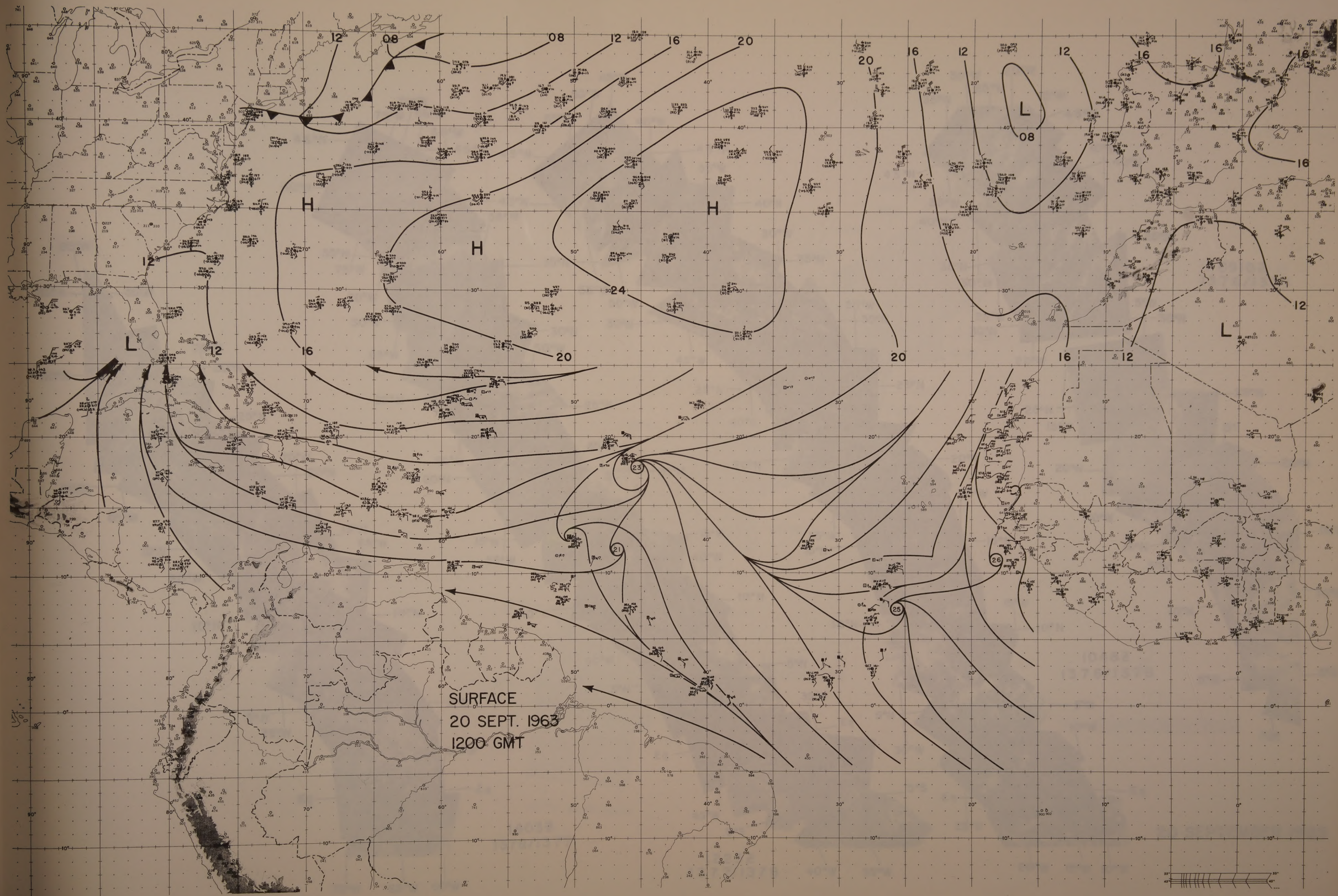
19 SEPTEMBER 1963

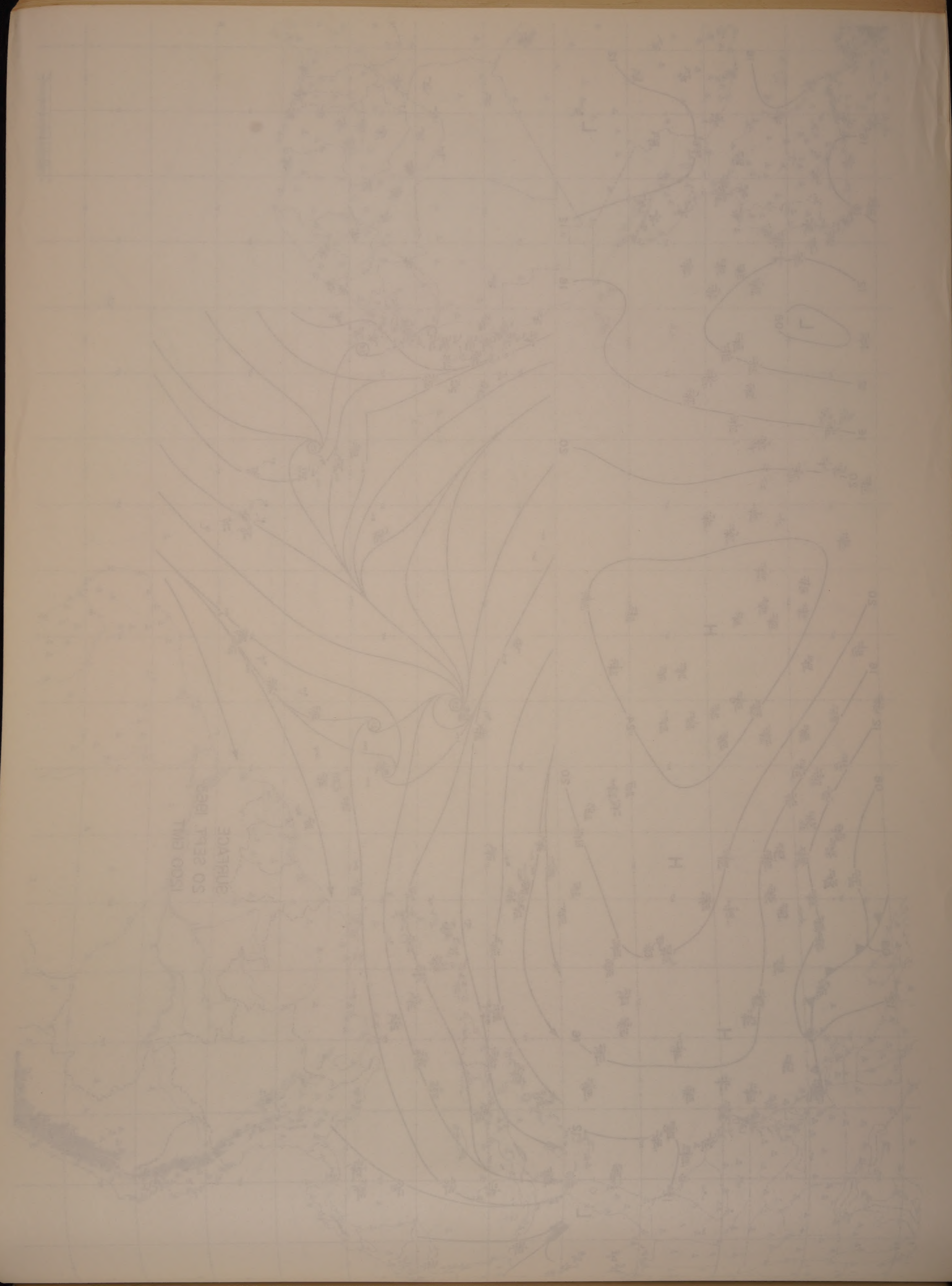


CLOUD MAP
19 SEPT. 1963
1200 GMT


CLOUD MAP
19 SEPT 1963
1200 GMT

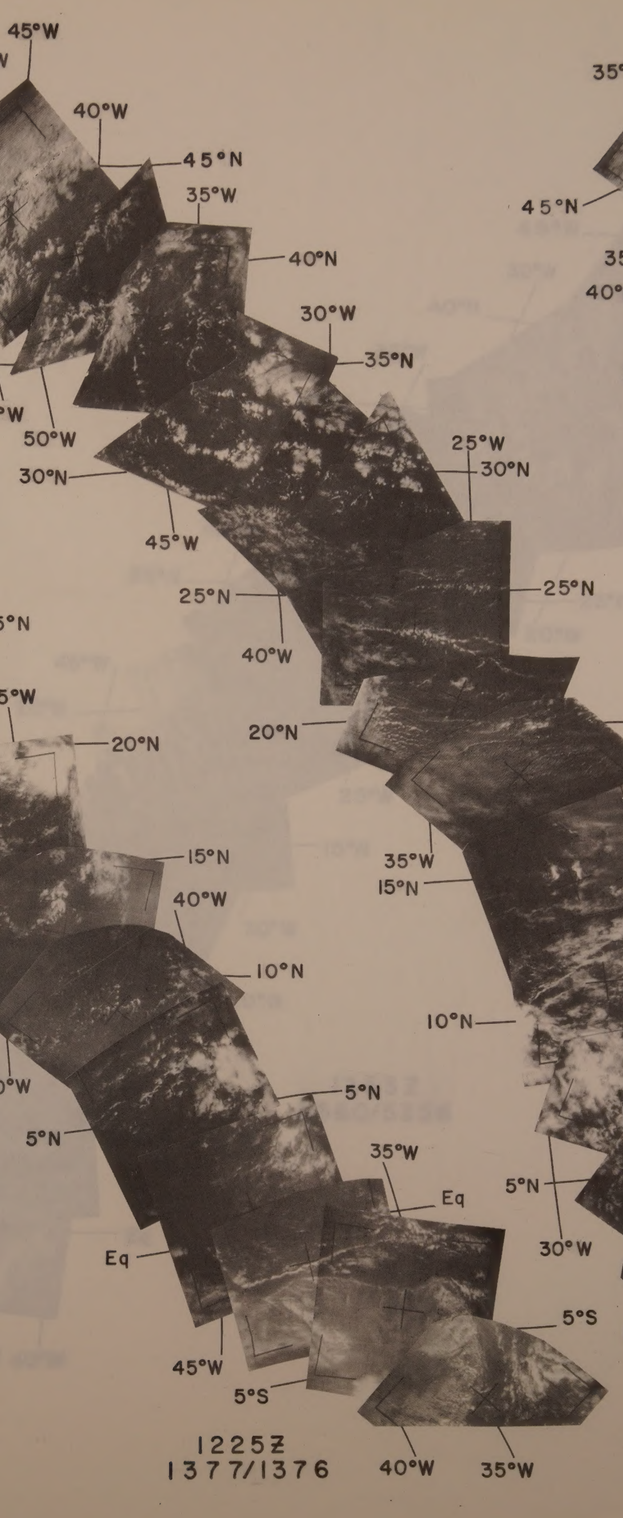

200 MB
19 SEPT. 1963
1200 GMT


H
H
H
L
L
L
12
08
16
20
24
23
21
26
25
SURFACE
20 SEPT. 1963
1200 GMT

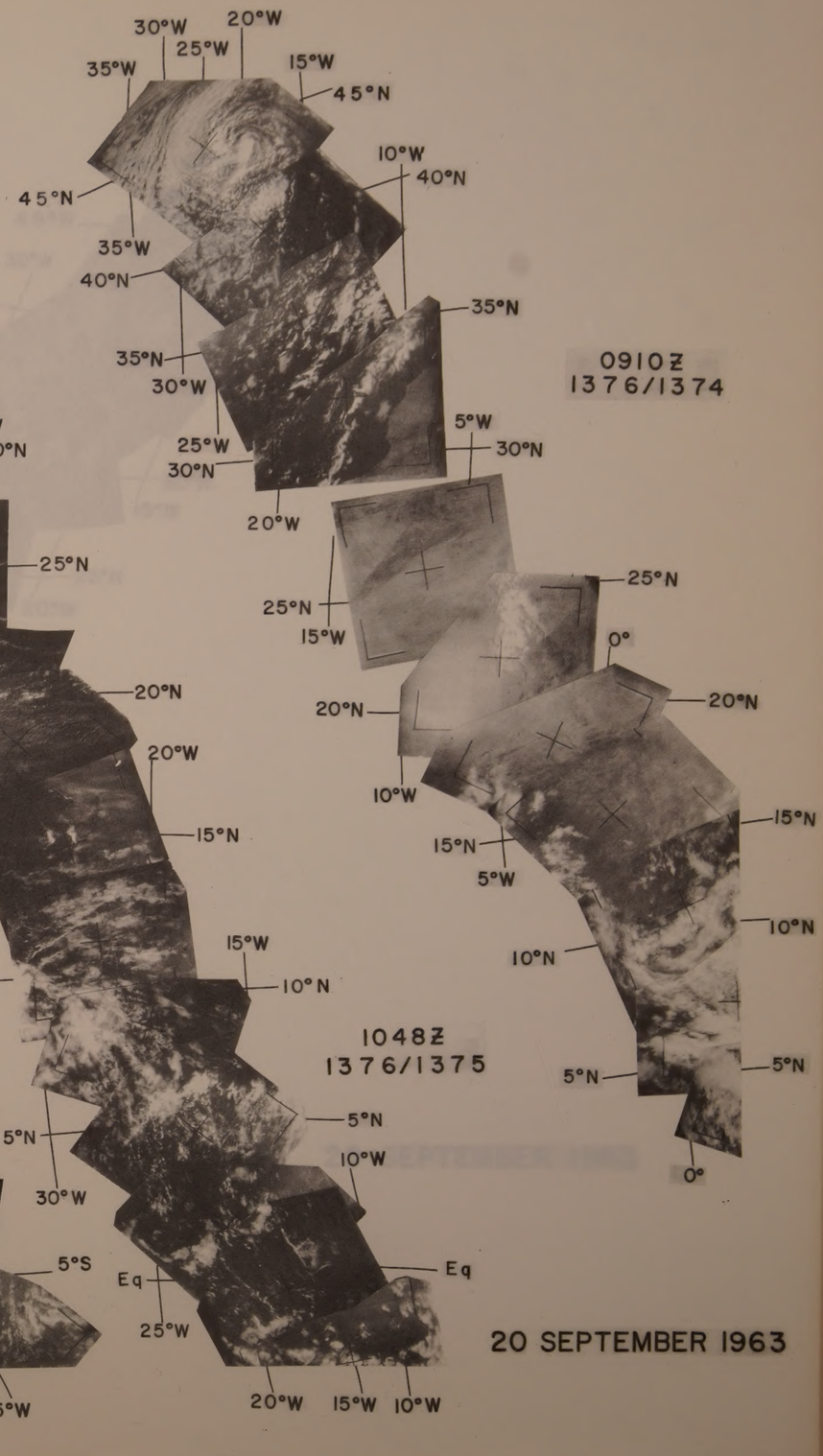

100 BM
SO SELL BED
SURFACE

1403Z
1378/1377

1225Z
1377/1376

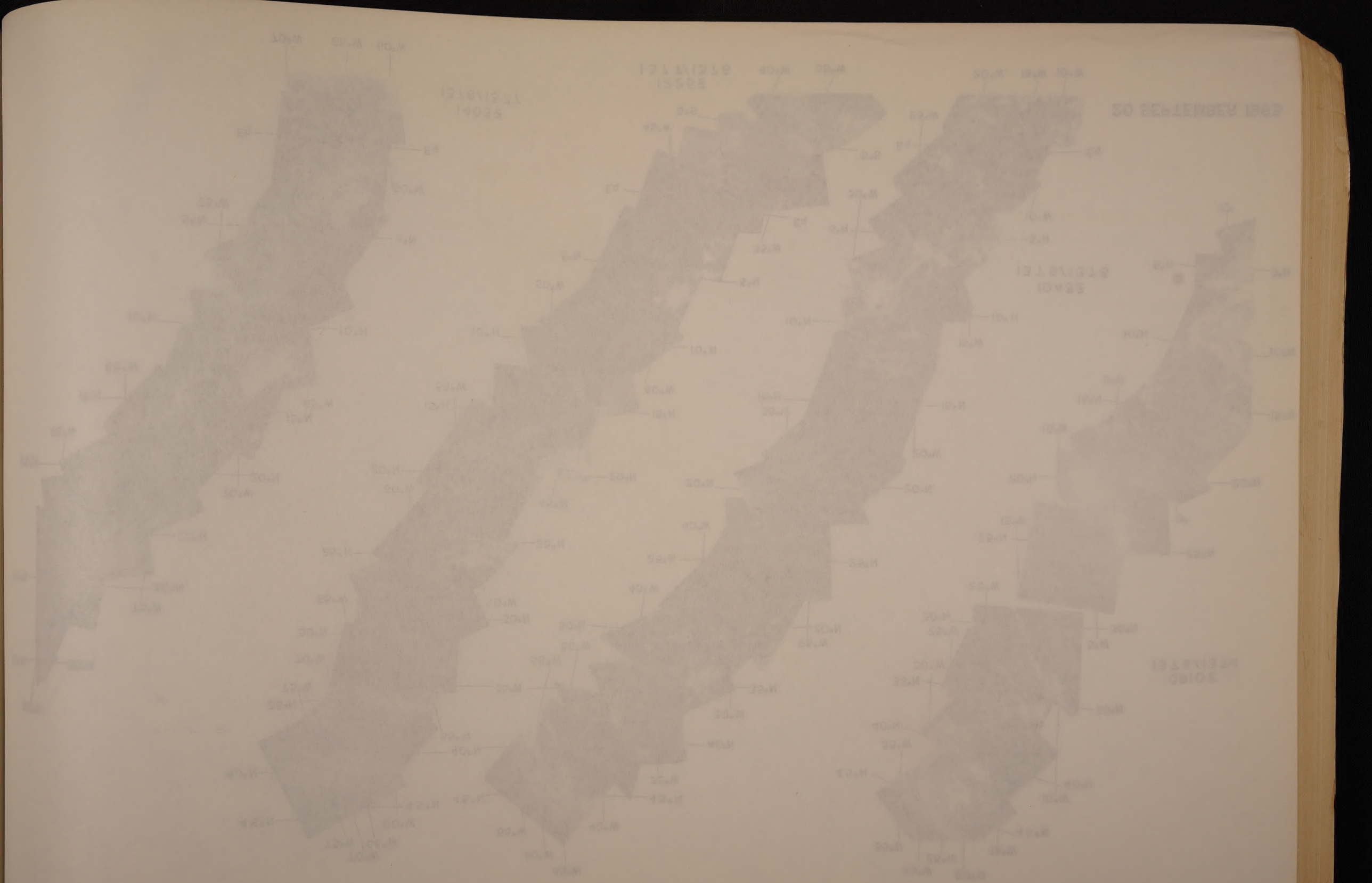


1048Z
1376/1375



0910Z
1376/1374

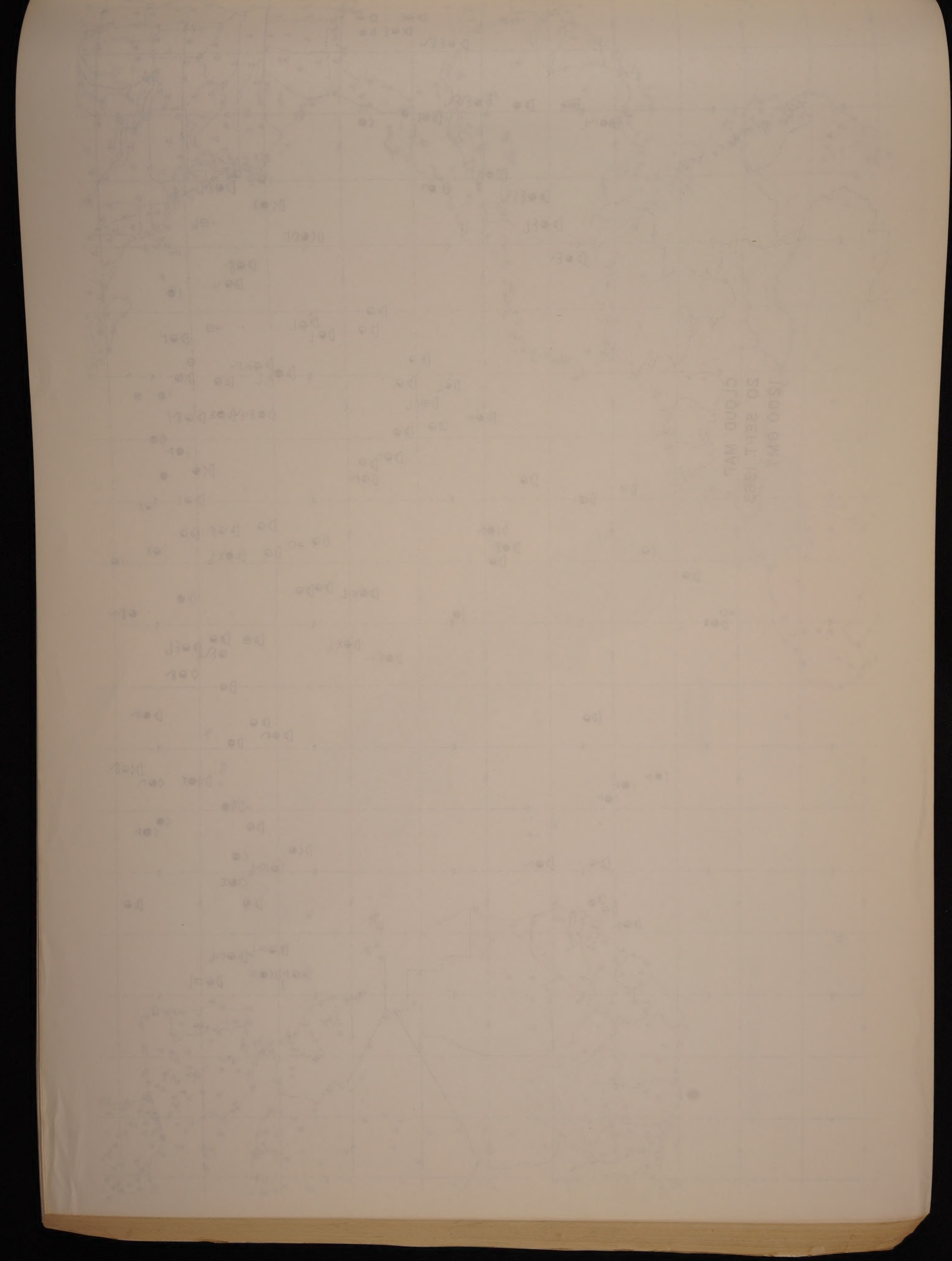
20 SEPTEMBER 1963

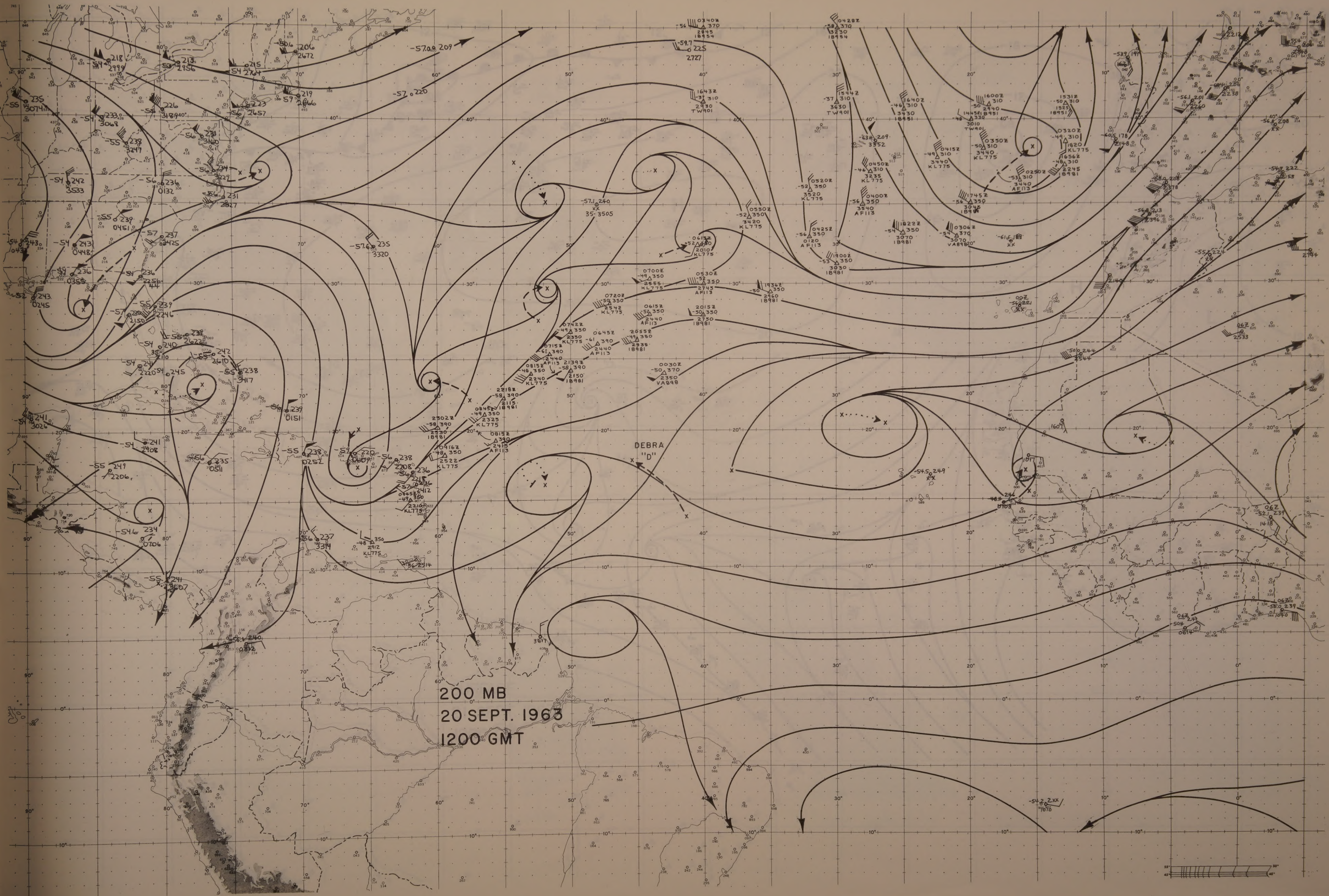


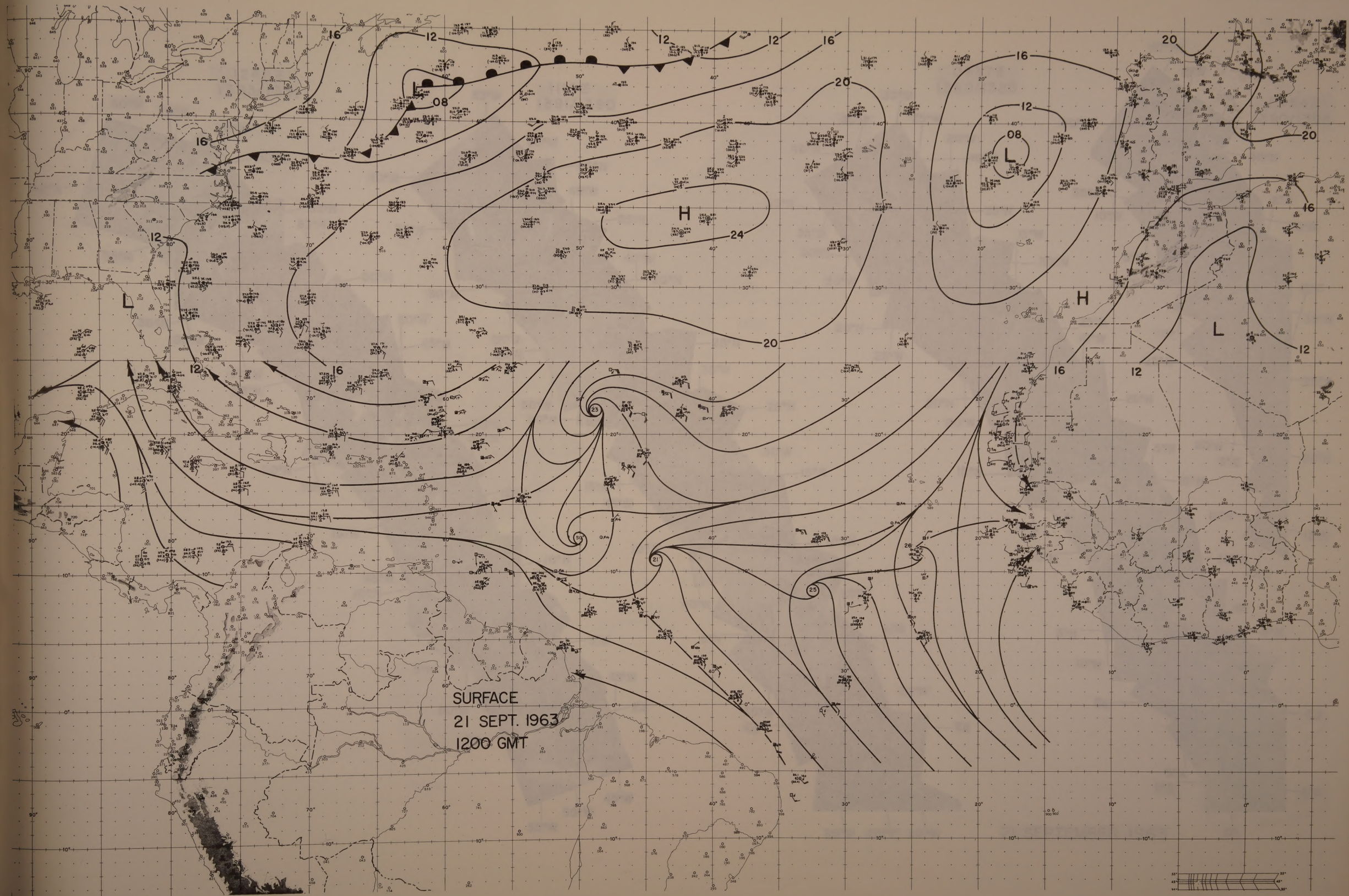
12532
5360/5356

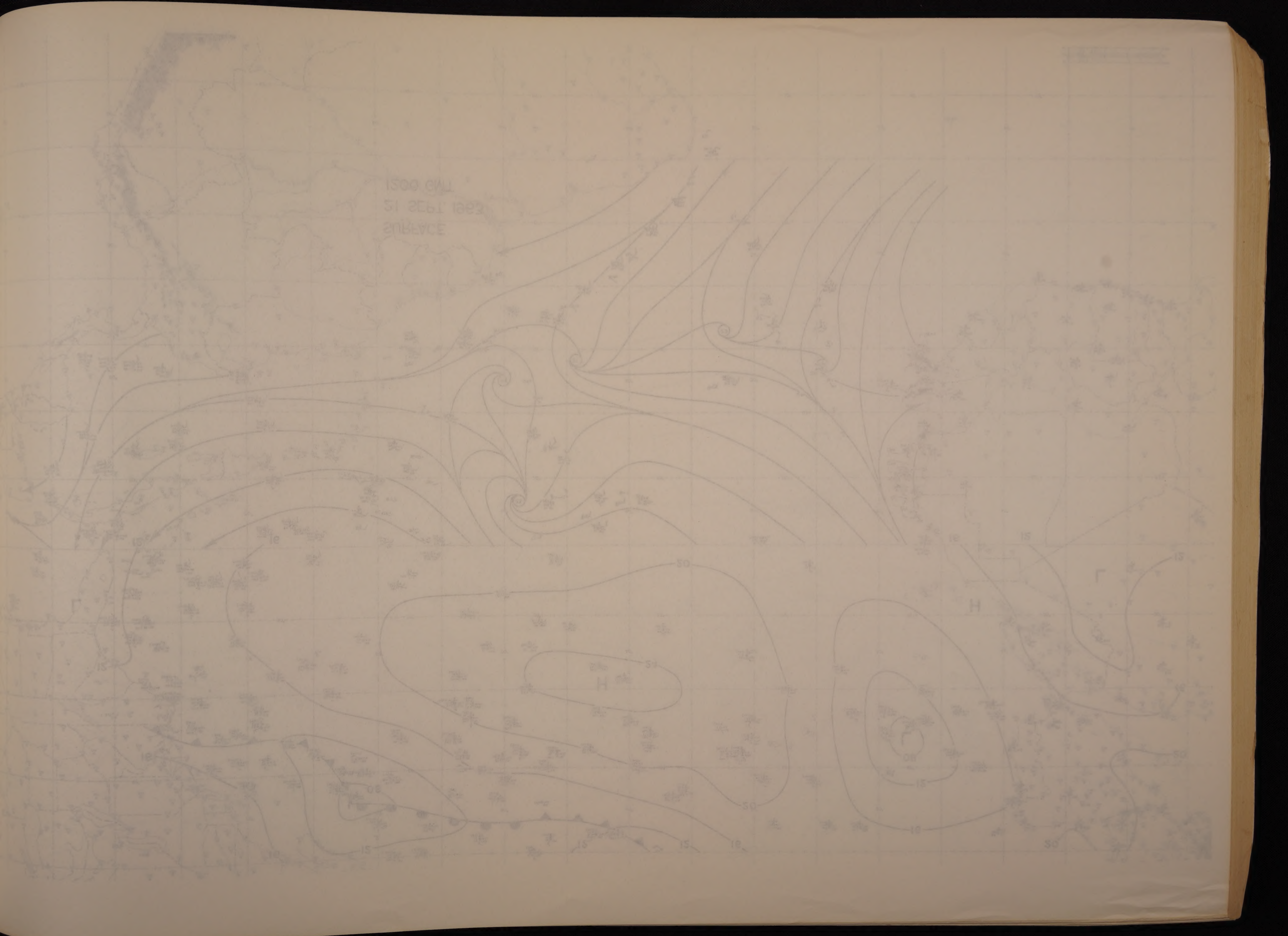
20 SEPTEMBER 1963

CLOUD MAP
20 SEPT. 1963
1200 GMT

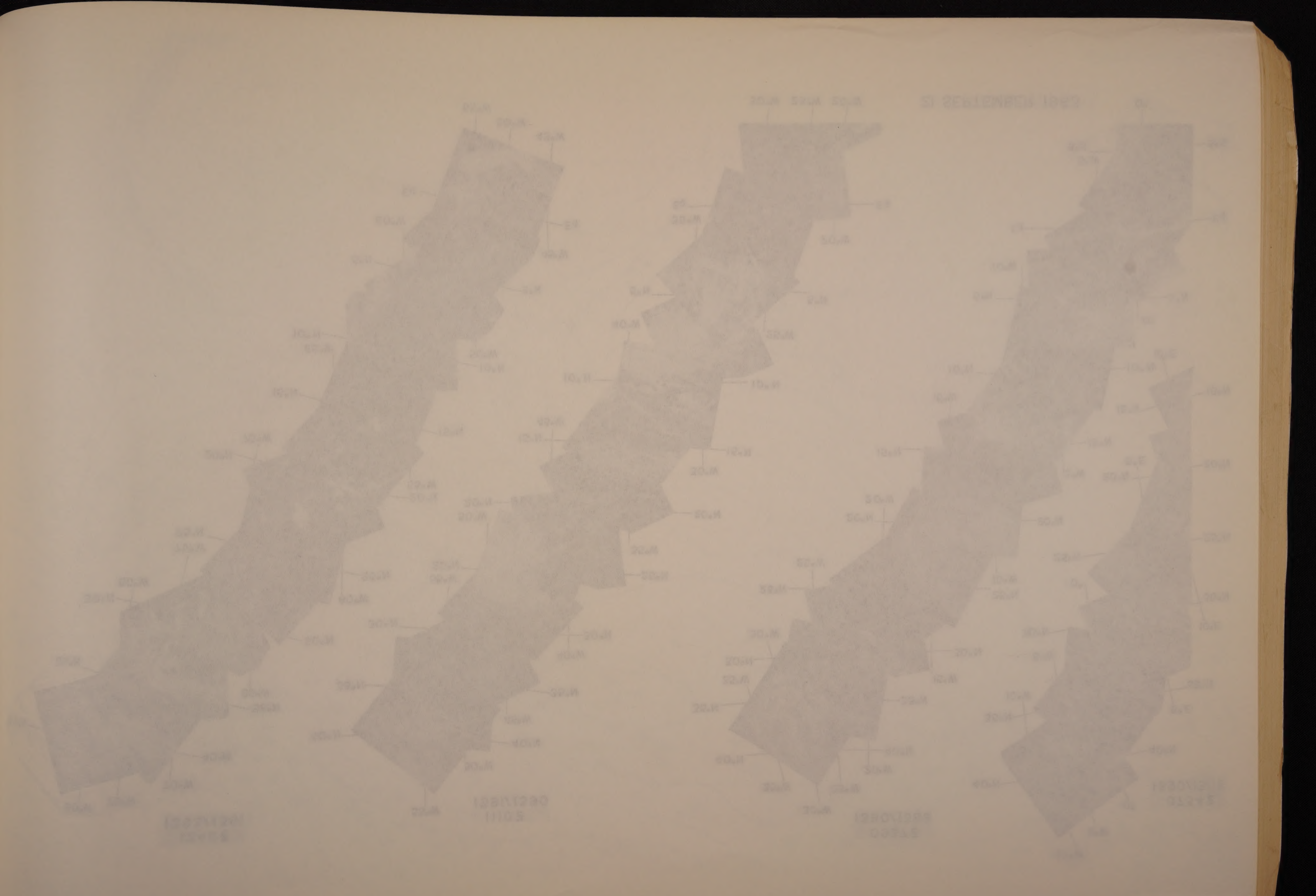



DEBRA
"D"
200 MB
20 SEPT. 1963
1200 GMT


SURFACE
21 SEPT. 1963
1200 GMT



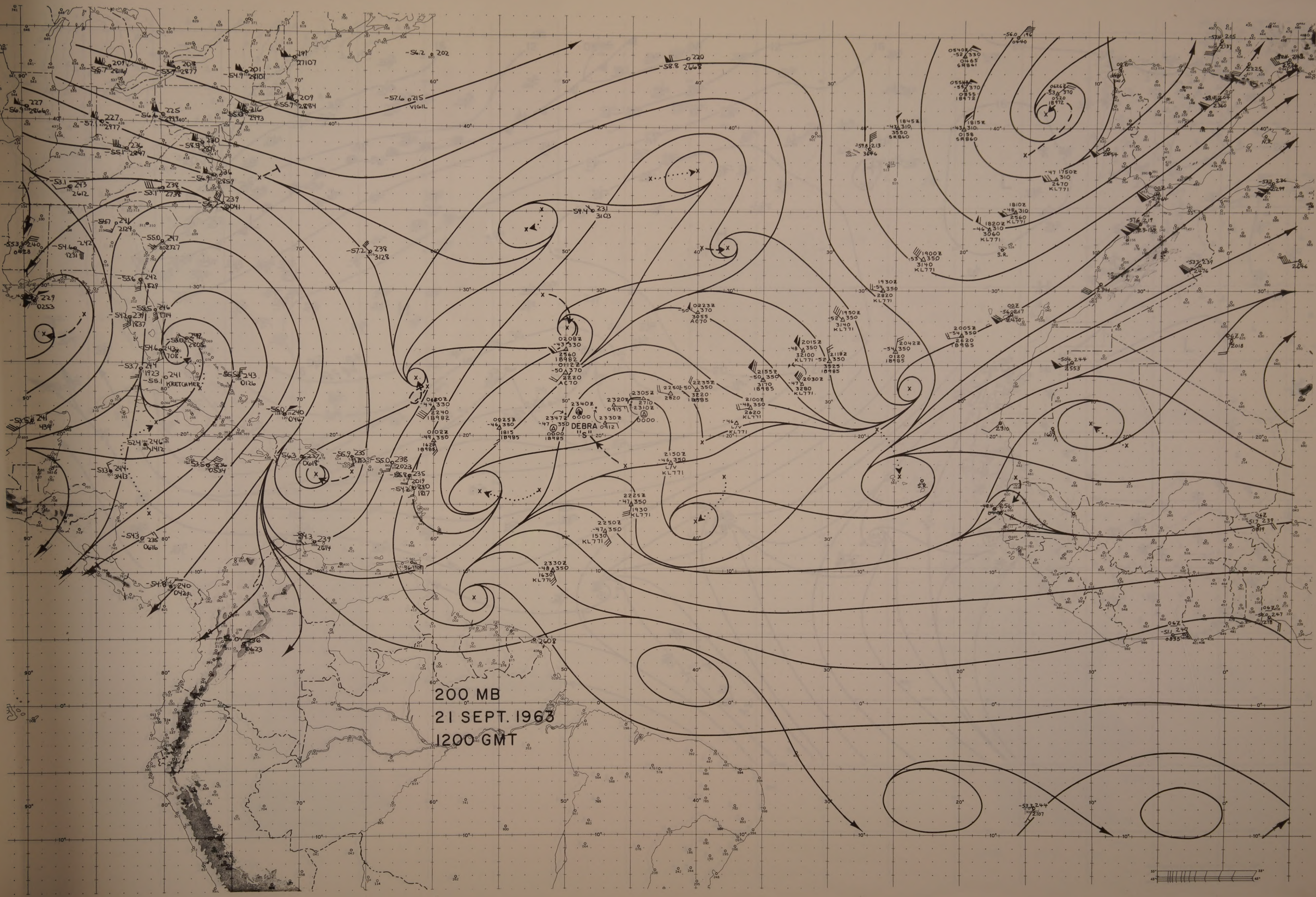
1248Z
1393/1391
80°W
75°W
70°W
40°N
35°N
65°W
30°N
60°W
25°N
55°W
20°N
15°N
10°N
50°W
5°N
45°W
Eq
1110Z
1391/1390
55°W
50°W
40°N
45°W
35°N
40°W
30°N
25°N
35°W
20°N
30°W
15°N
10° N
25°W
5°N
20°W
Eq
0937Z
1390/1389
30°W
35°W
25°W
20°W
40°N
35°N
15°W
30°N
25°N
10°W
20°N
5°W
15°N
0754Z
1390/1388
10°W
5°W
0°
40°N
35°N
5° E
10°W
30°N
10°E
25°N
20°N
5°E
15°N
10° N
10°E
5°N
0°
Eq
5°W
5°S
21 SEPTEMBER 1963

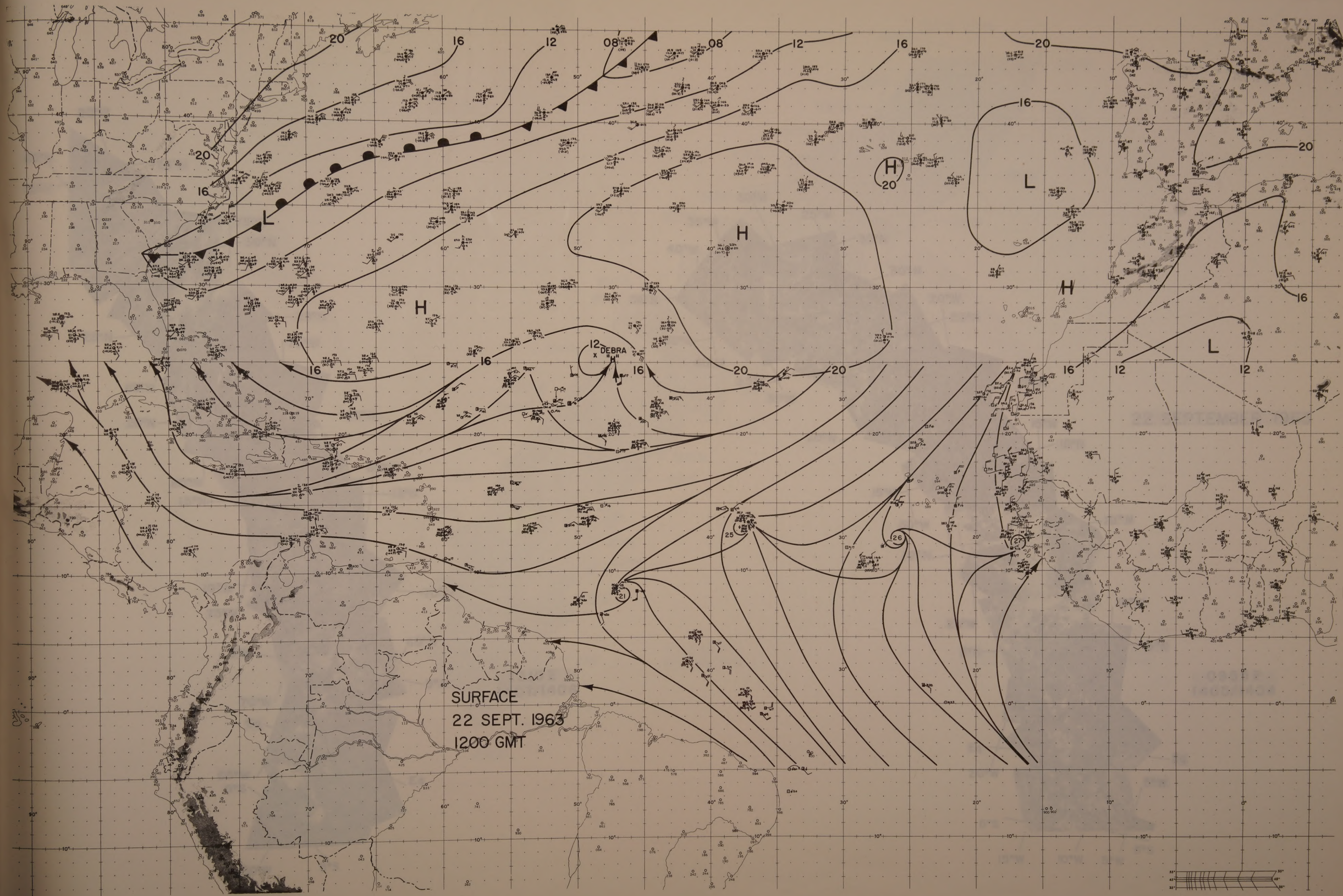


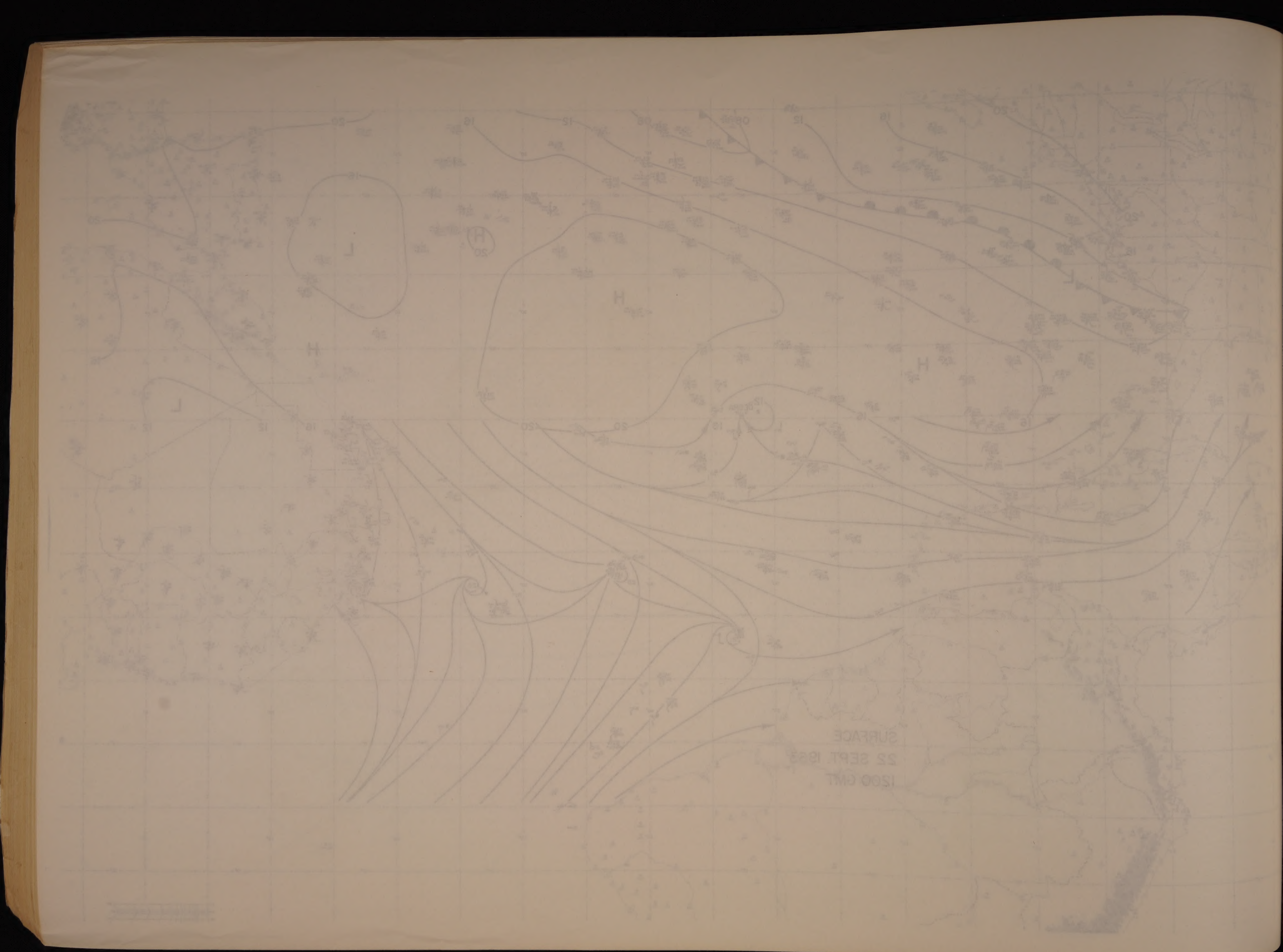
1332Z
5377/5371

21 SEPTEMBER 1963

CLOUD MAP
21 SEPT. 1963
1200 GMT


200 MB
21 SEPT. 1963
1200 GMT
DEBRA
KRETCHMER
VIGIL
S.R.
N.R.


DEBRA
SURFACE
22 SEPT. 1963
1200 GMT


H
L
H
H
L
SURFACE
22 SEPT. 1955
1200 GMT

1310Z
1407/1406

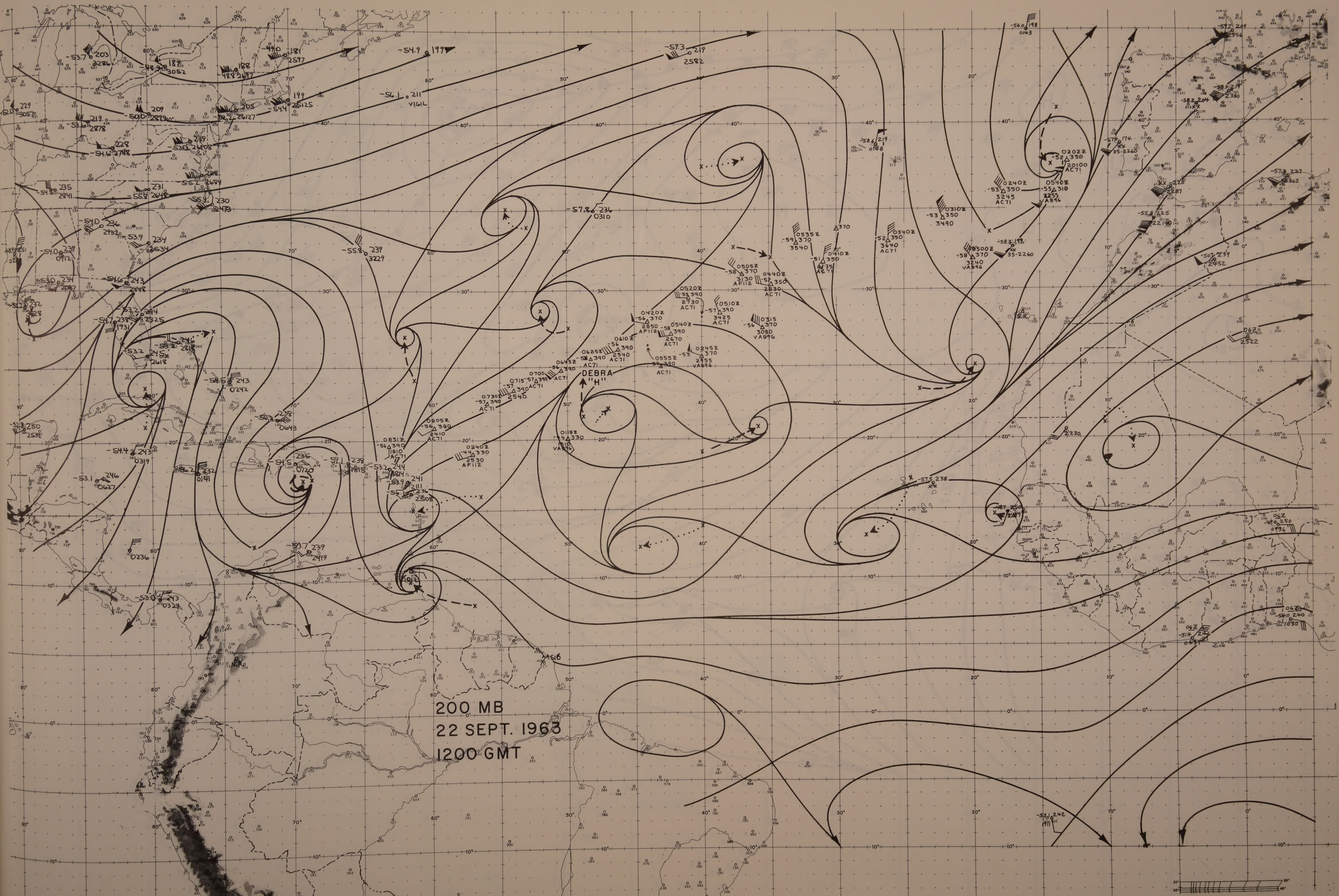
22 SEPTEMBER 1963

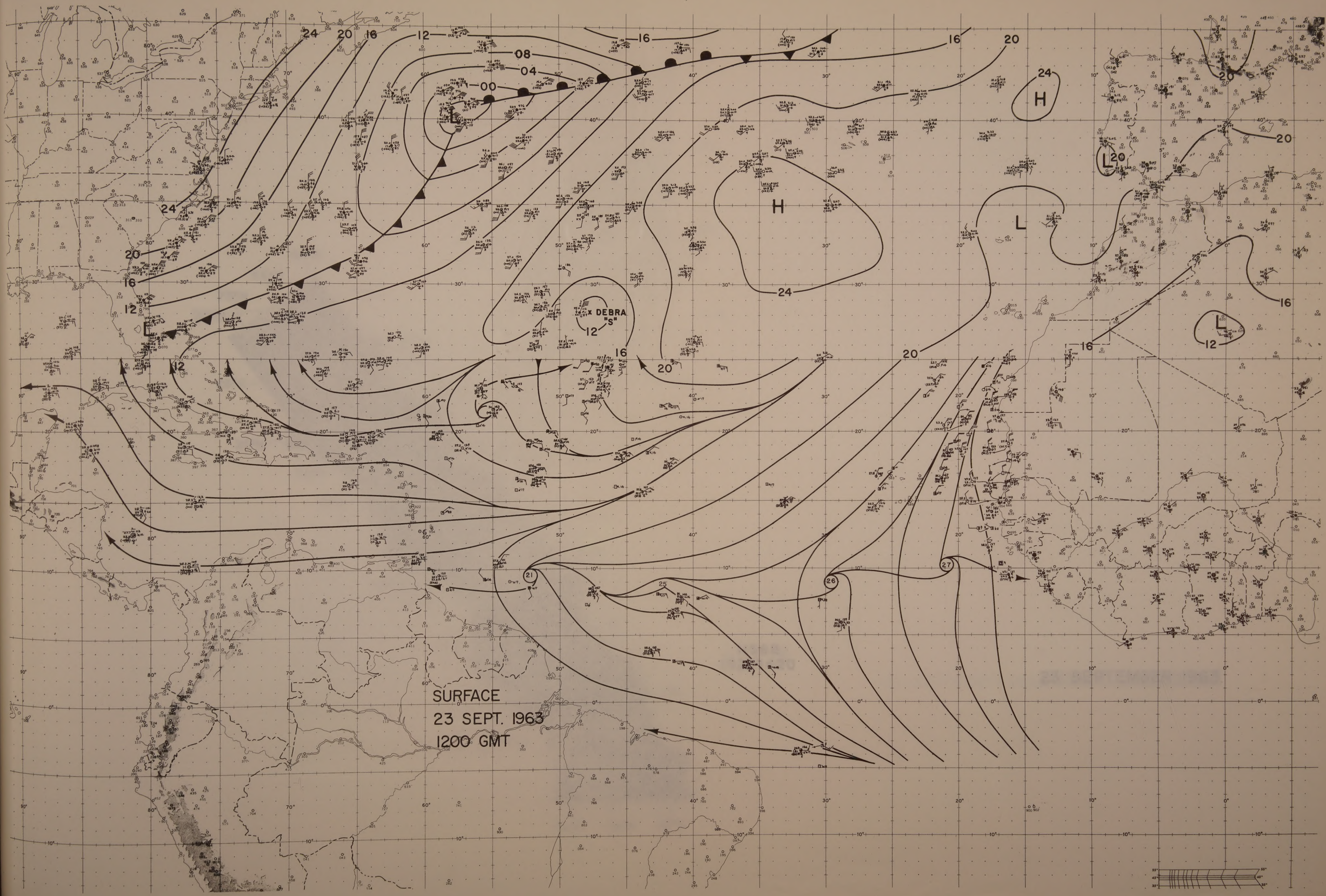
0955Z
1405/1404

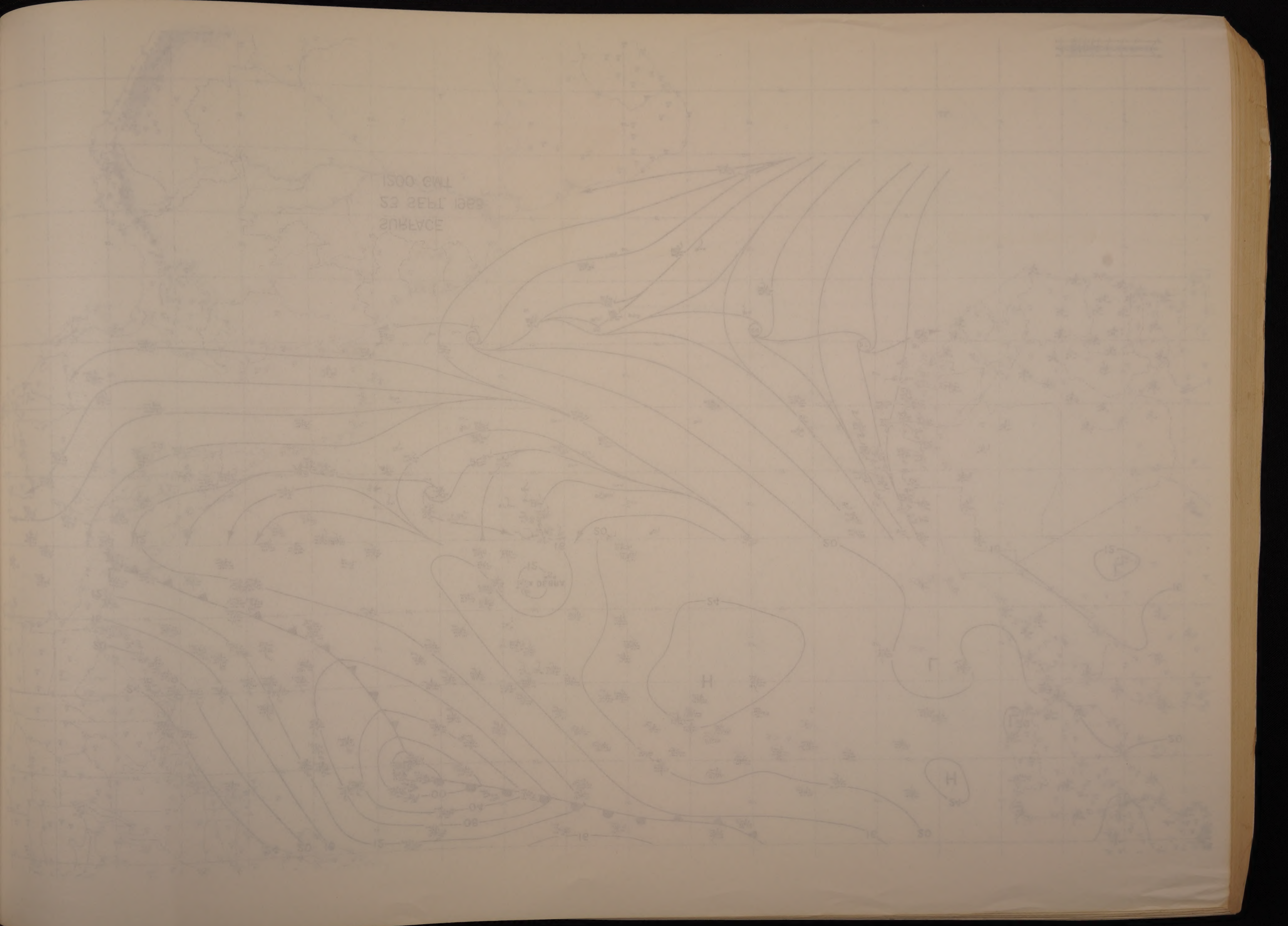
1235 Z
5391/5385

22 SEPTEMBER 1963

CLOUD MAP
22 SEPT. 1963
1200 GMT


DEBRA
"H"
200 MB
22 SEPT. 1963
1200 GMT


HURRICANE DEBRA "S"
SURFACE
23 SEPT. 1963
1200 GMT


1500 GMT
23 SEPT 1959
SURFACE
H
H
L

1156Z
1421/1420

23 SEPTEMBER 1963

23 SEPTEMBER 1963

CLOUD MAP
23 SEPT. 1963
1200 GMT

CLOUD MAP

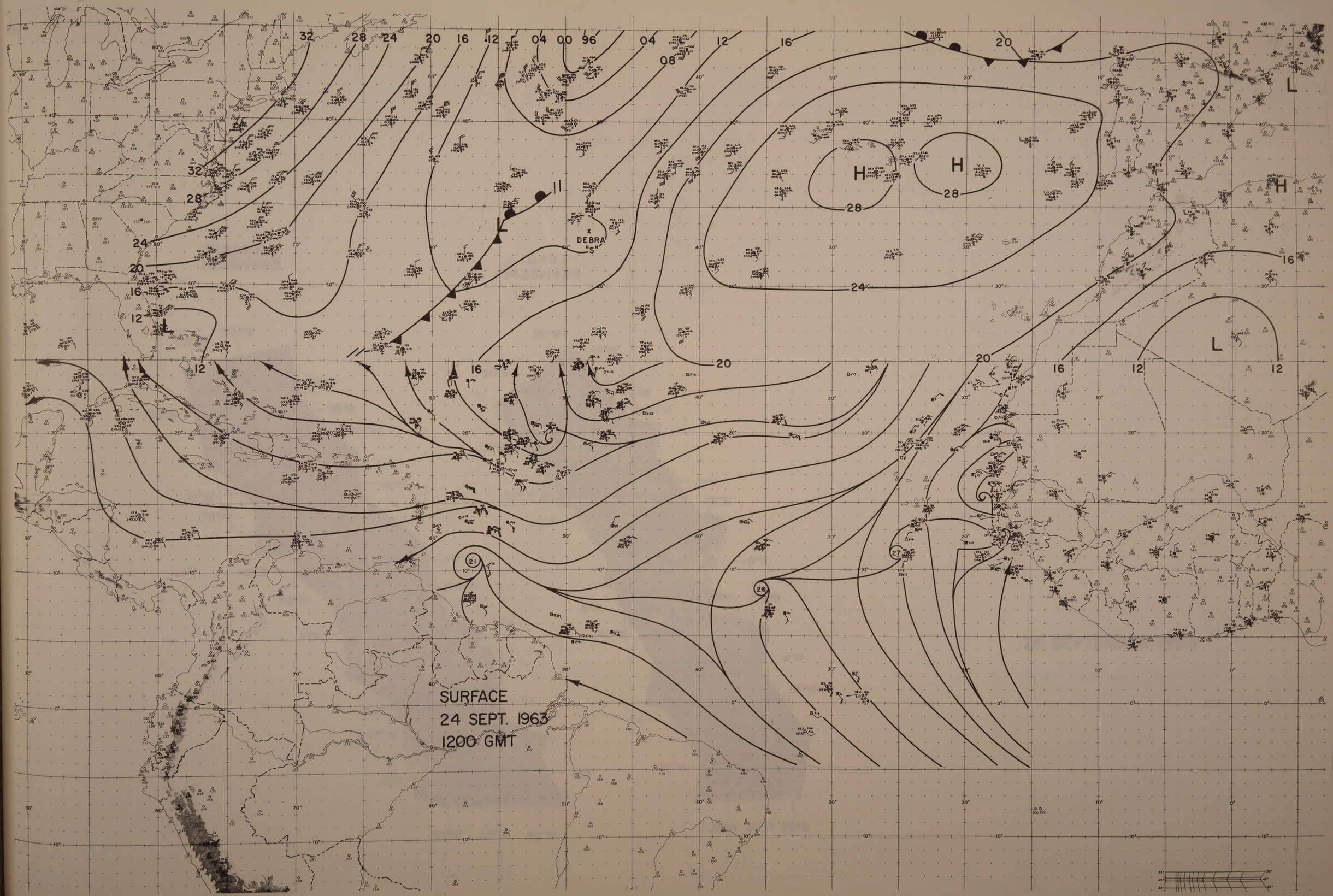
52 SEPT 1952

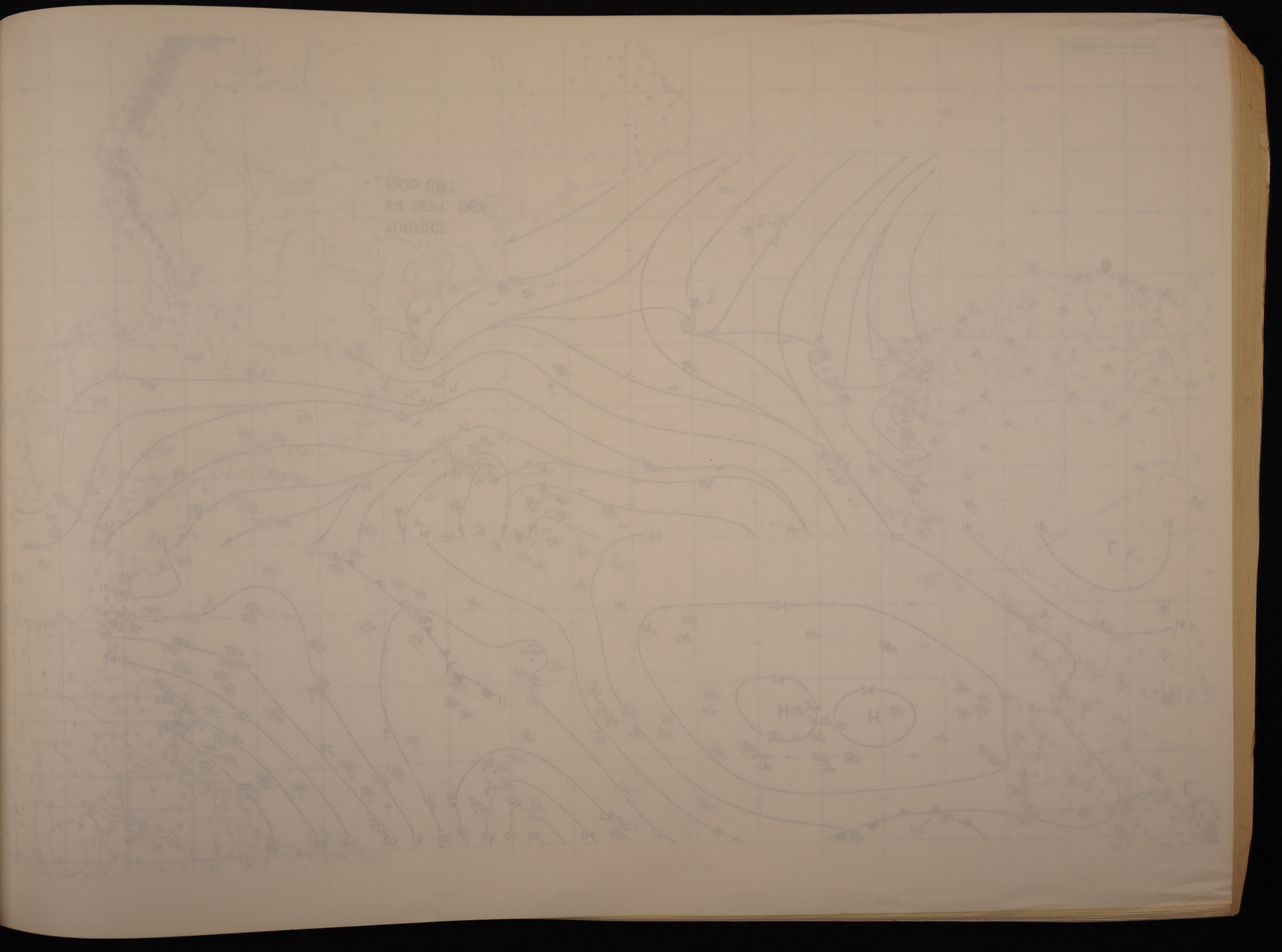
1500 GMT

DEBRA
"S"

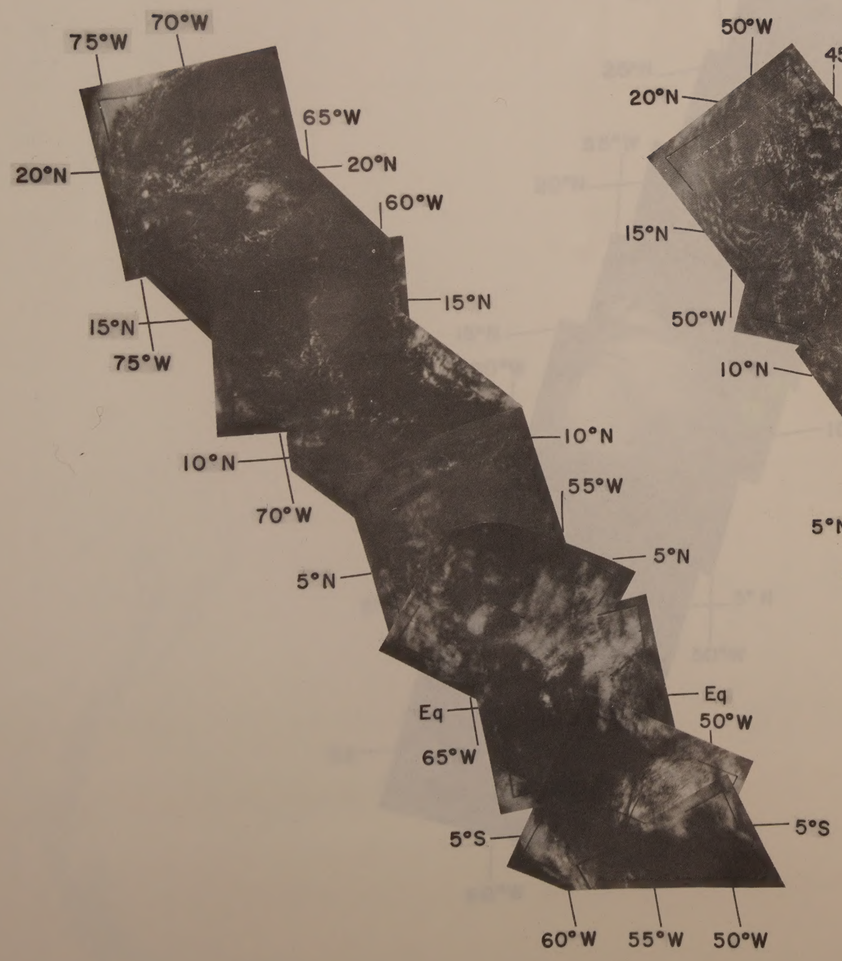
EDITH
"D"

200 MB
23 SEPT. 1963
1200 GMT

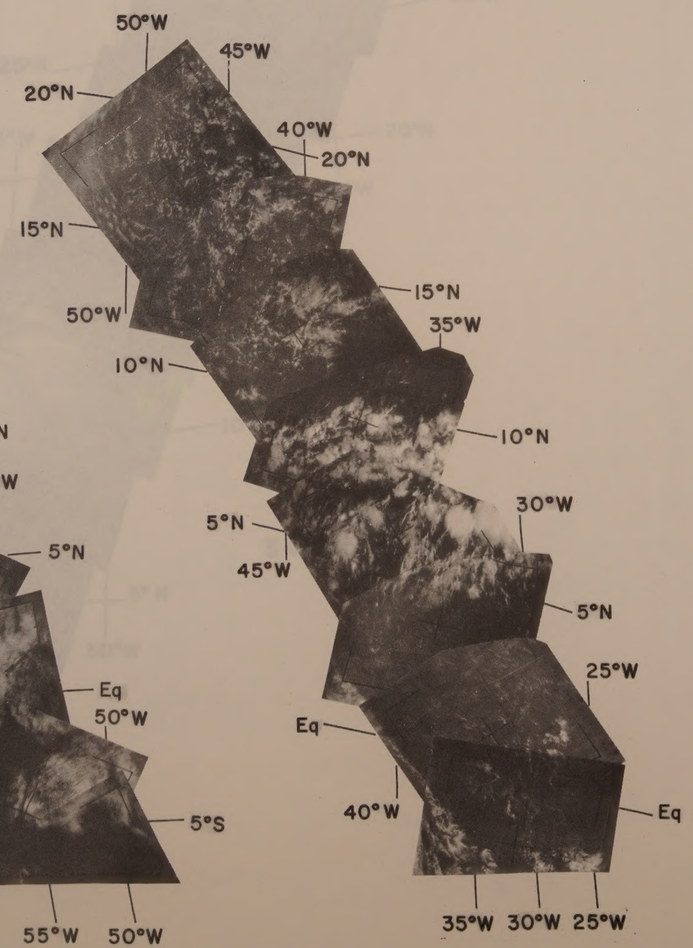

DEBRA
SURFACE
24 SEPT. 1963
1200 GMT



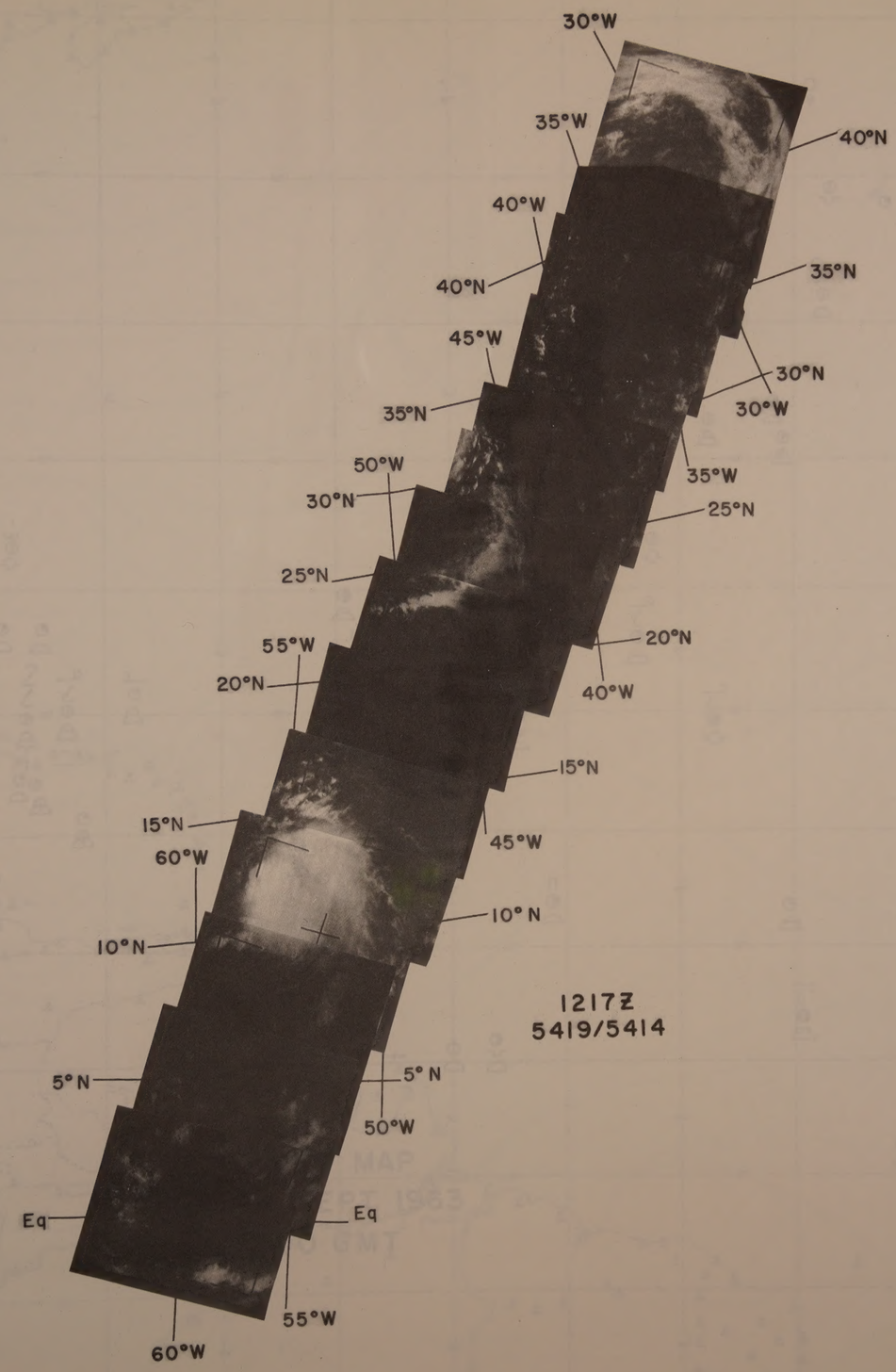
1219Z
1436/1435



1042Z
1435/1434



24 SEPTEMBER 1963



1217Z
5419/5414

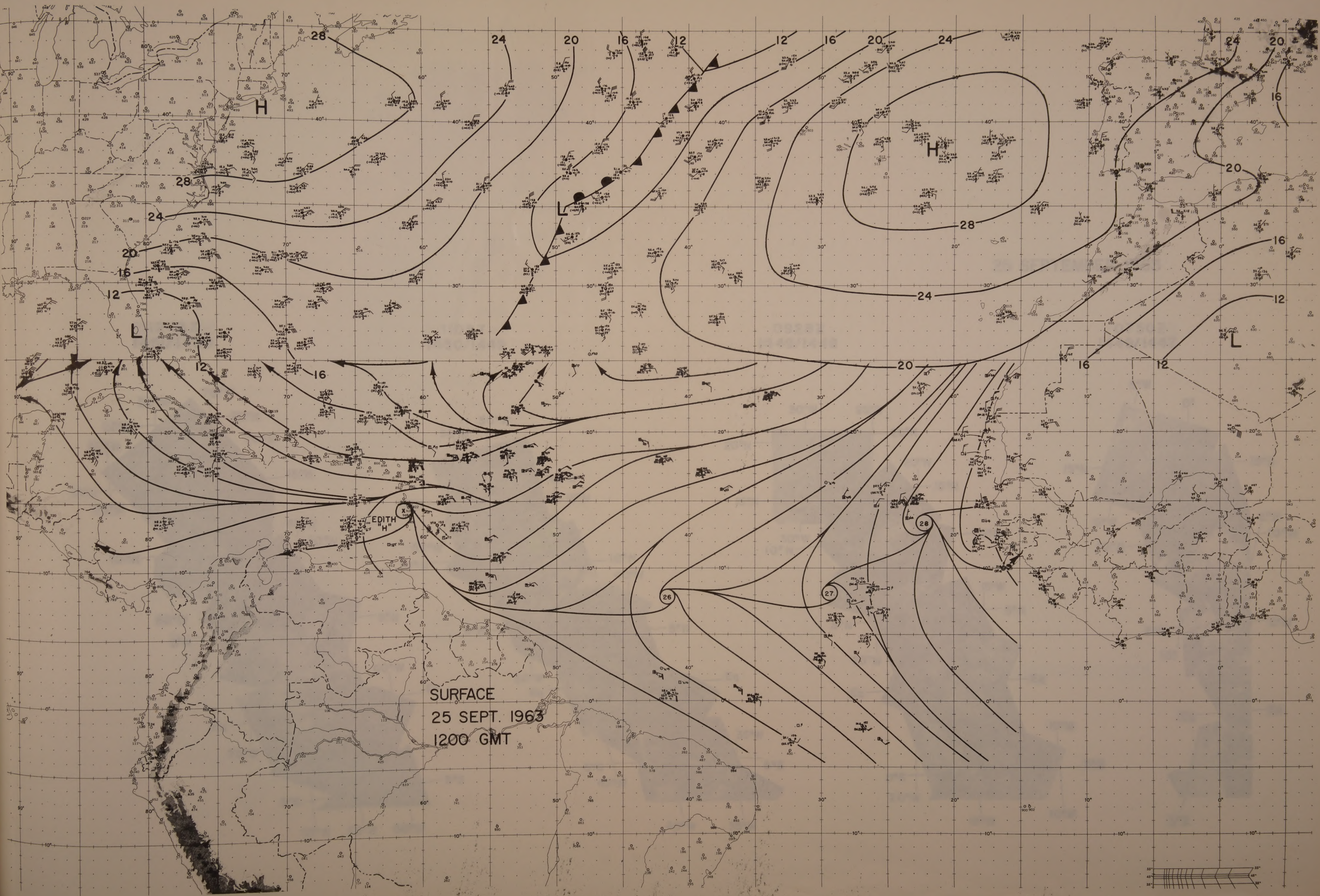
24 SEPTEMBER 1963

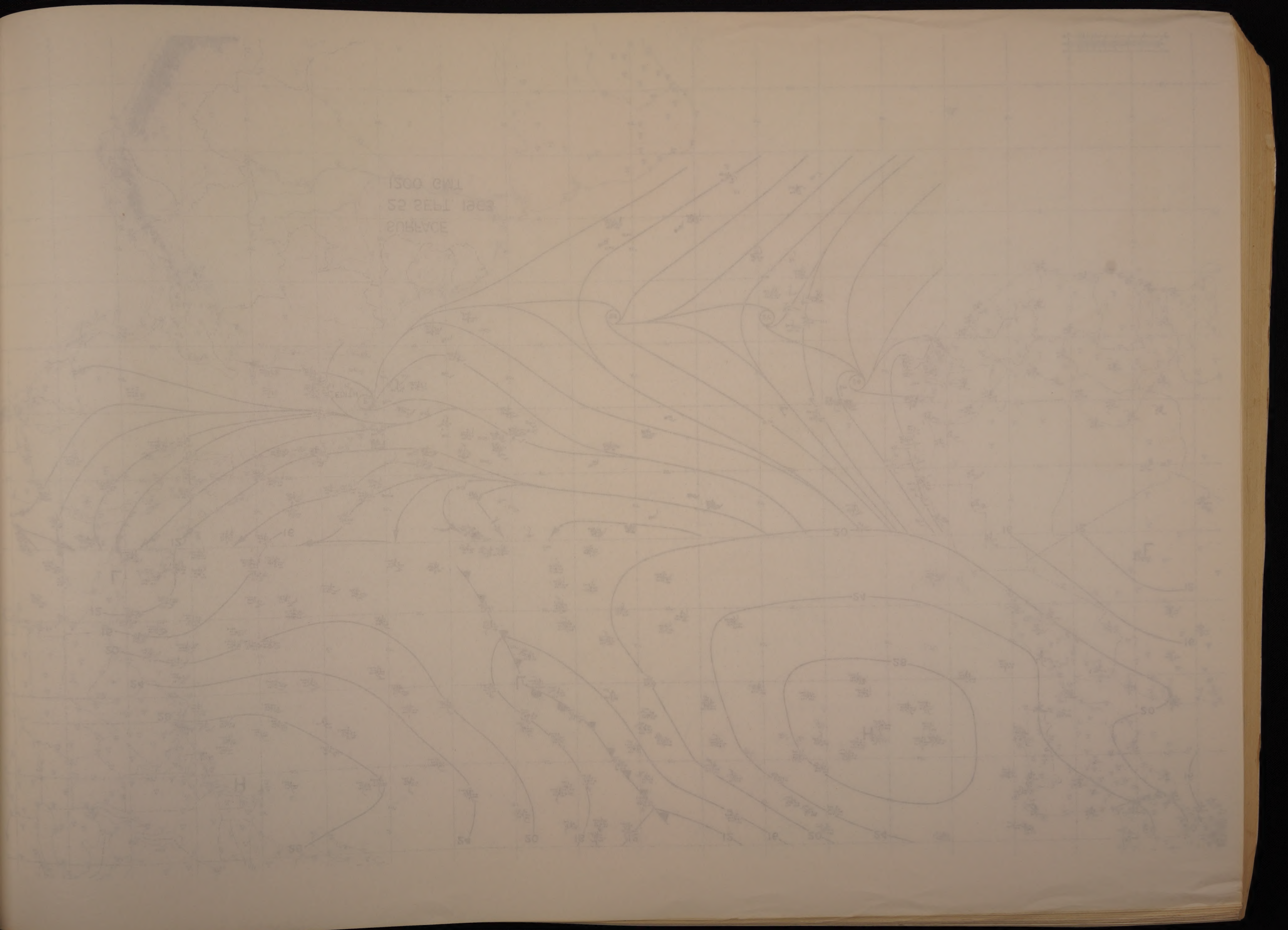
CLOUD MAP
24 SEPT. 1963
1200 GMT

DEBRA
"D"

EDITH
"D"

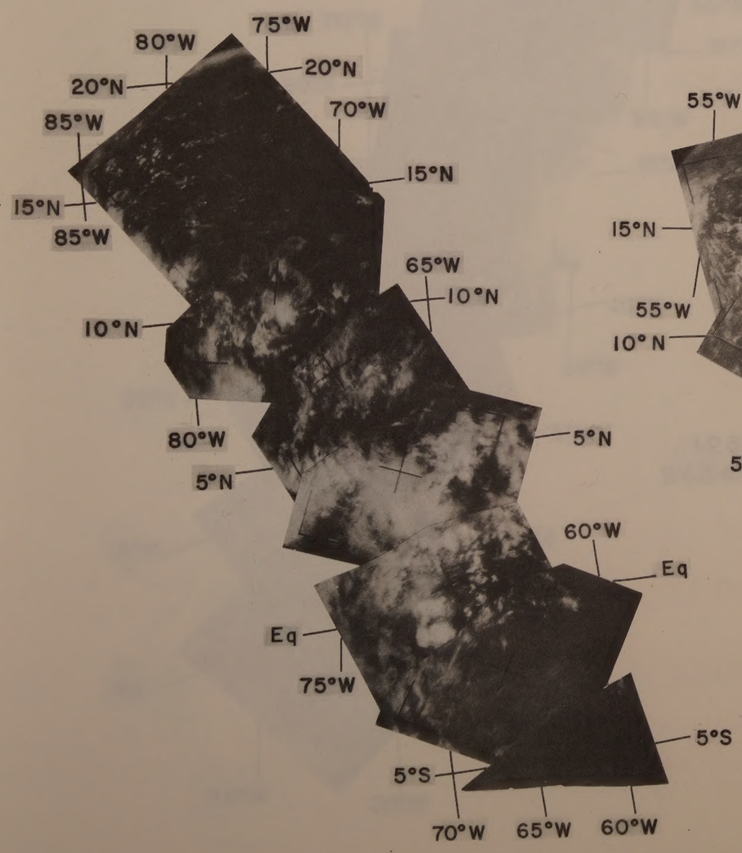
200 MB
24 SEPT. 1963
1200 GMT


H
H
L
L
L
28
24
20
16
12
12
16
20
24
28
24
20
16
12
20
16
12
16
20
24
28
24
20
16
12
EDITH
"H"
26
27
28
SURFACE
25 SEPT. 1963
1200 GMT

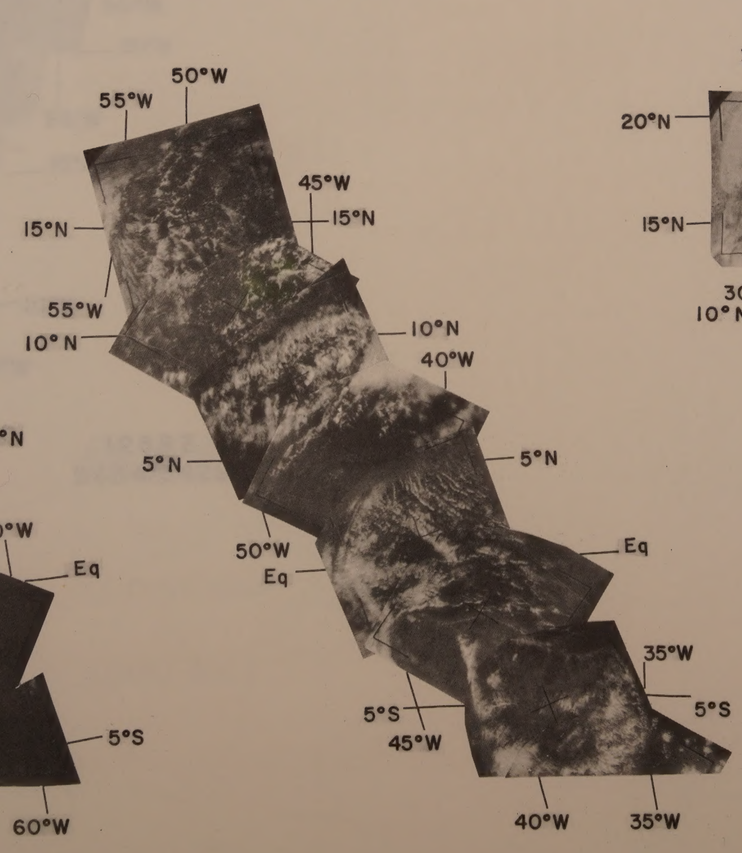


25 SEPTEMBER 1963

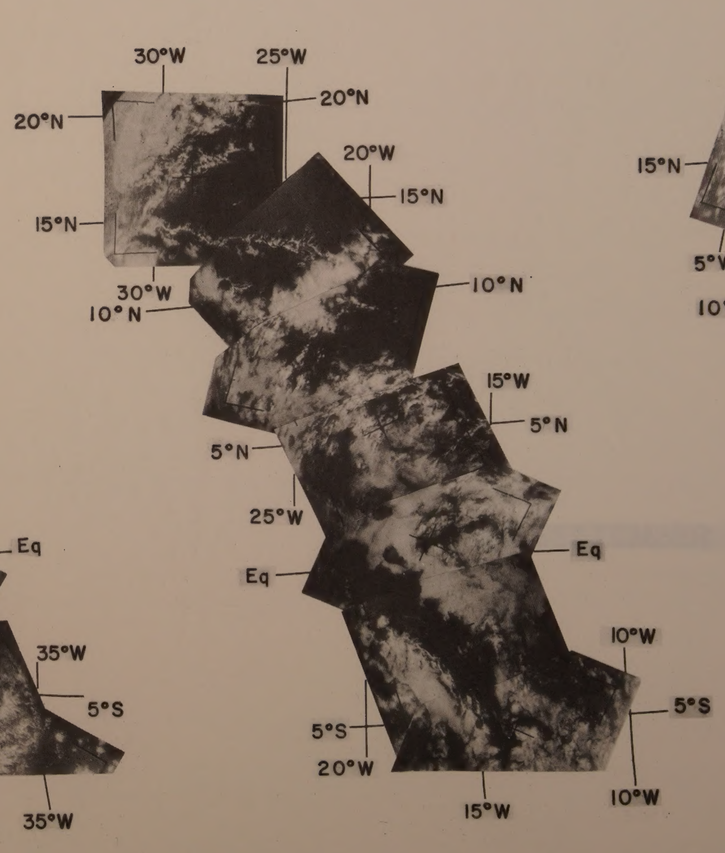
1243Z
1451/1450



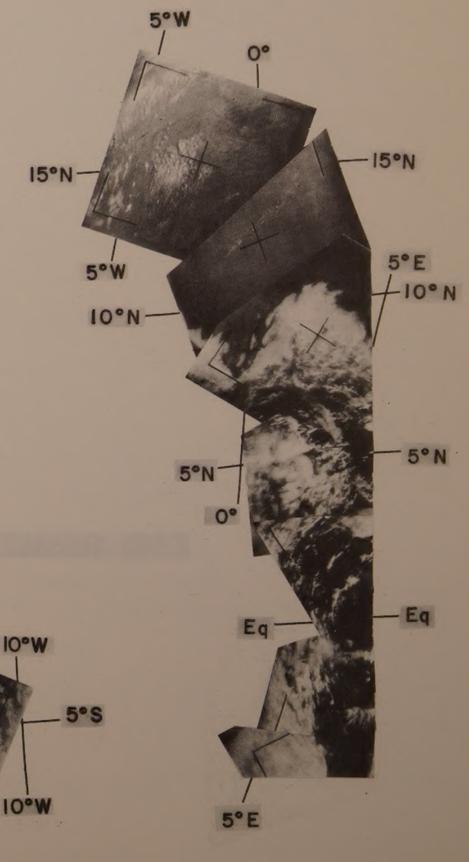
1105Z
1450/1449



0928Z
1449/1448

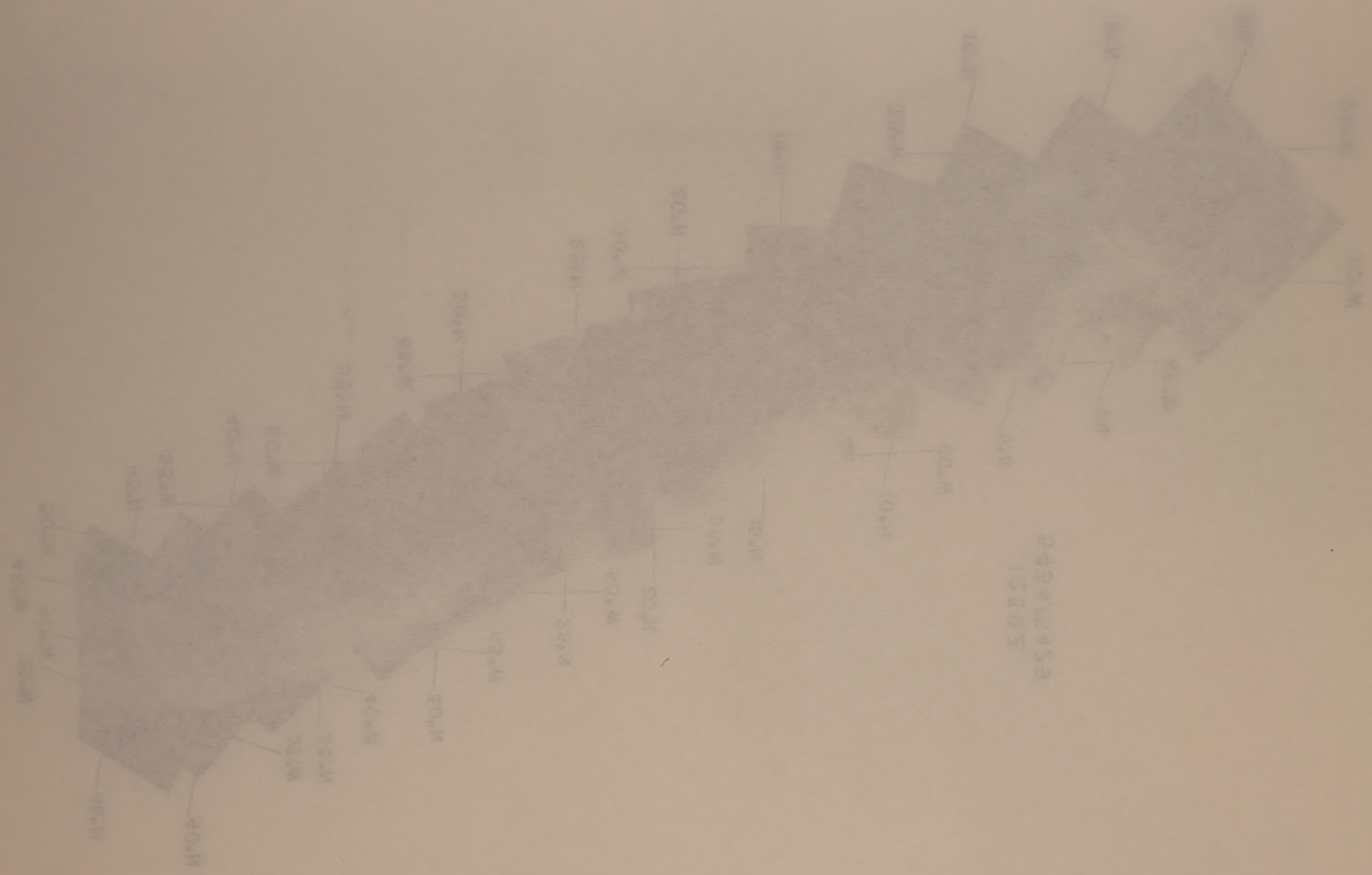


0750Z
1449/1447

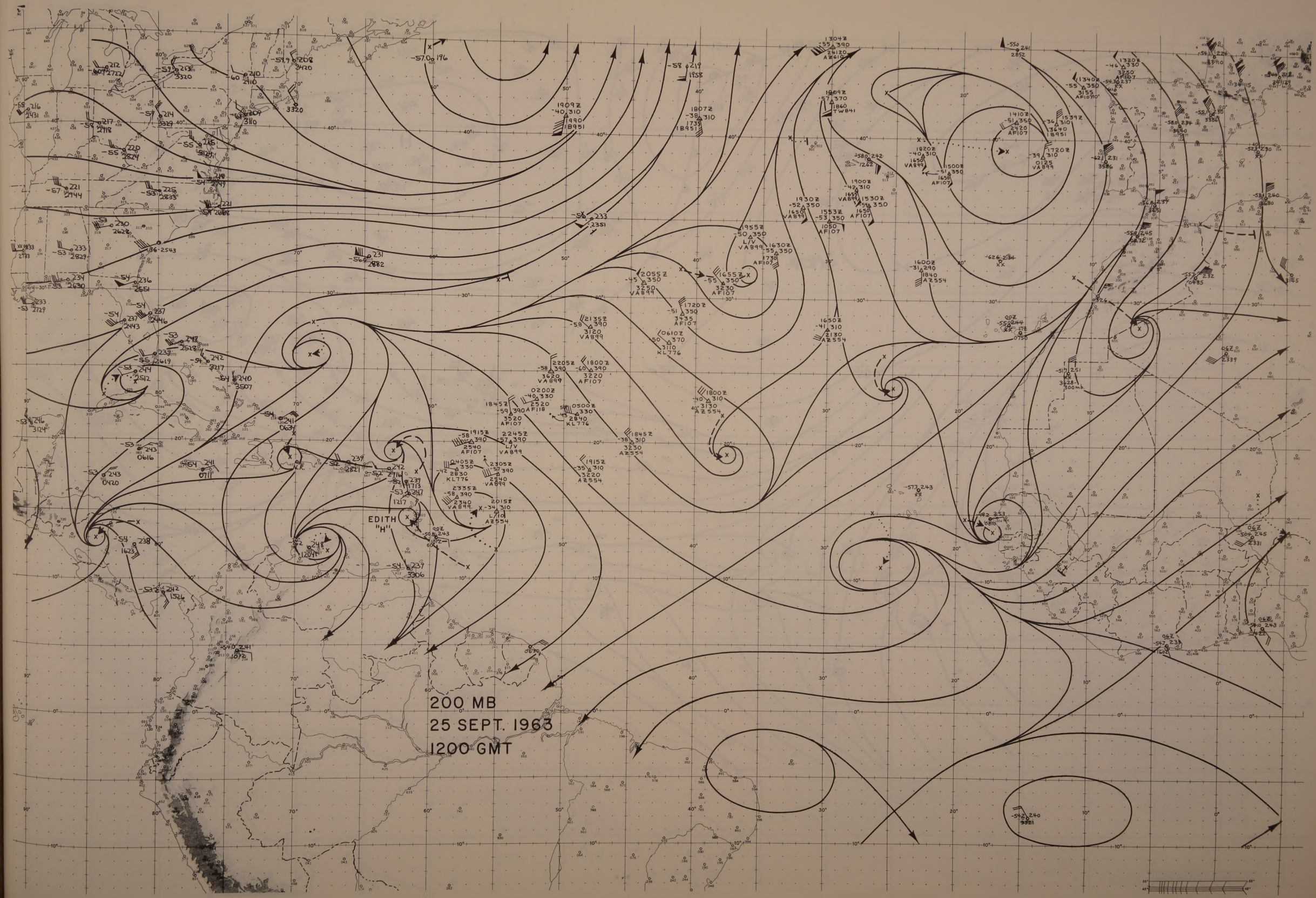


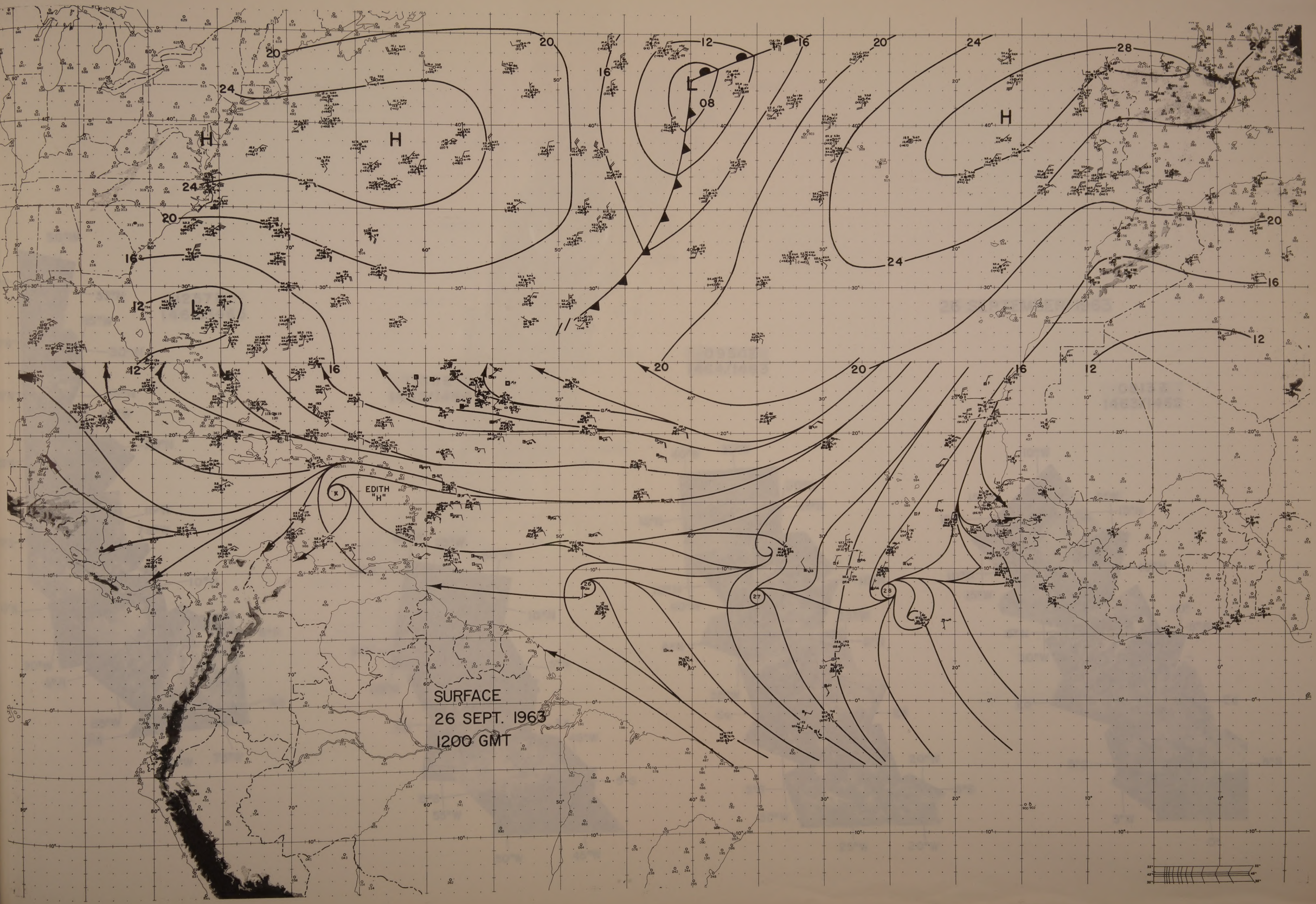
1258Z
5434/5429

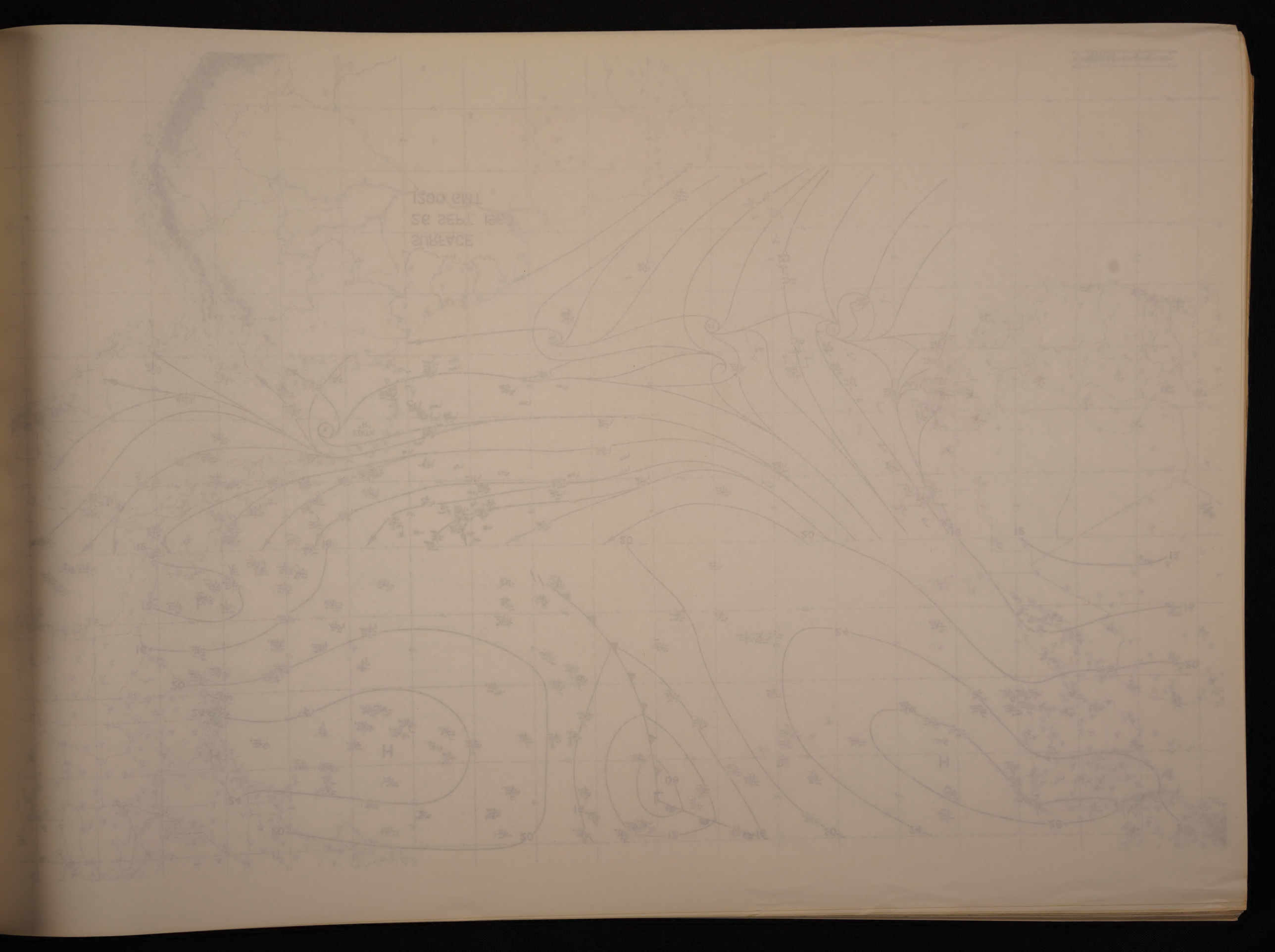
25 SEPTEMBER 1963



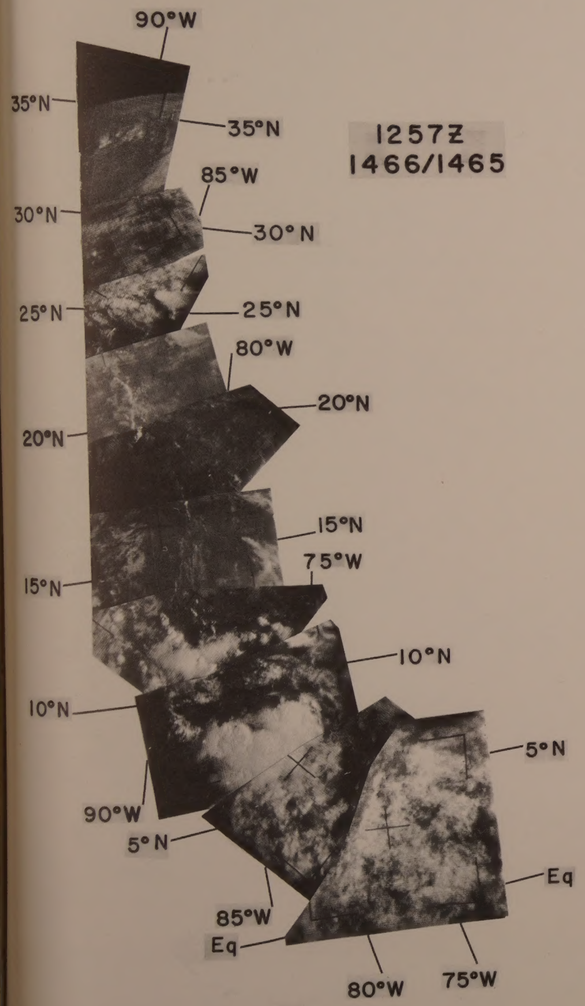
CLOUD MAP
25 SEPT. 1963
1200 GMT


200 MB
25 SEPT. 1963
1200 GMT
EDITH
"H"

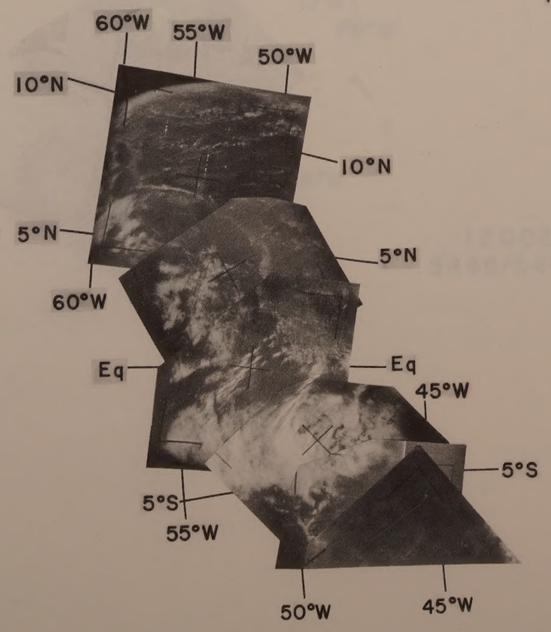

H
H
H
L
L
08
EDITH
"H"
SURFACE
26 SEPT. 1963
1200 GMT


SURFACE
H
H
H
50
50
50

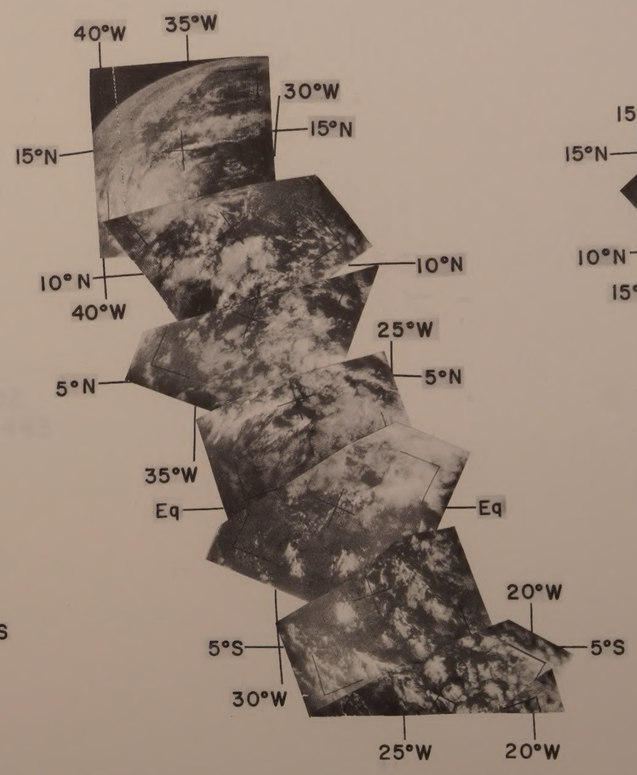
26 SEPTEMBER 1963



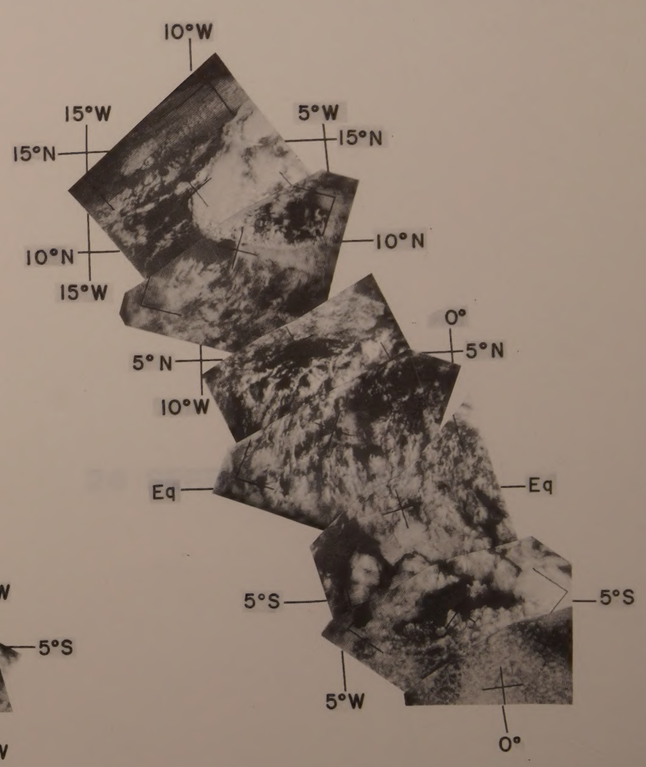
1257Z
1466/1465



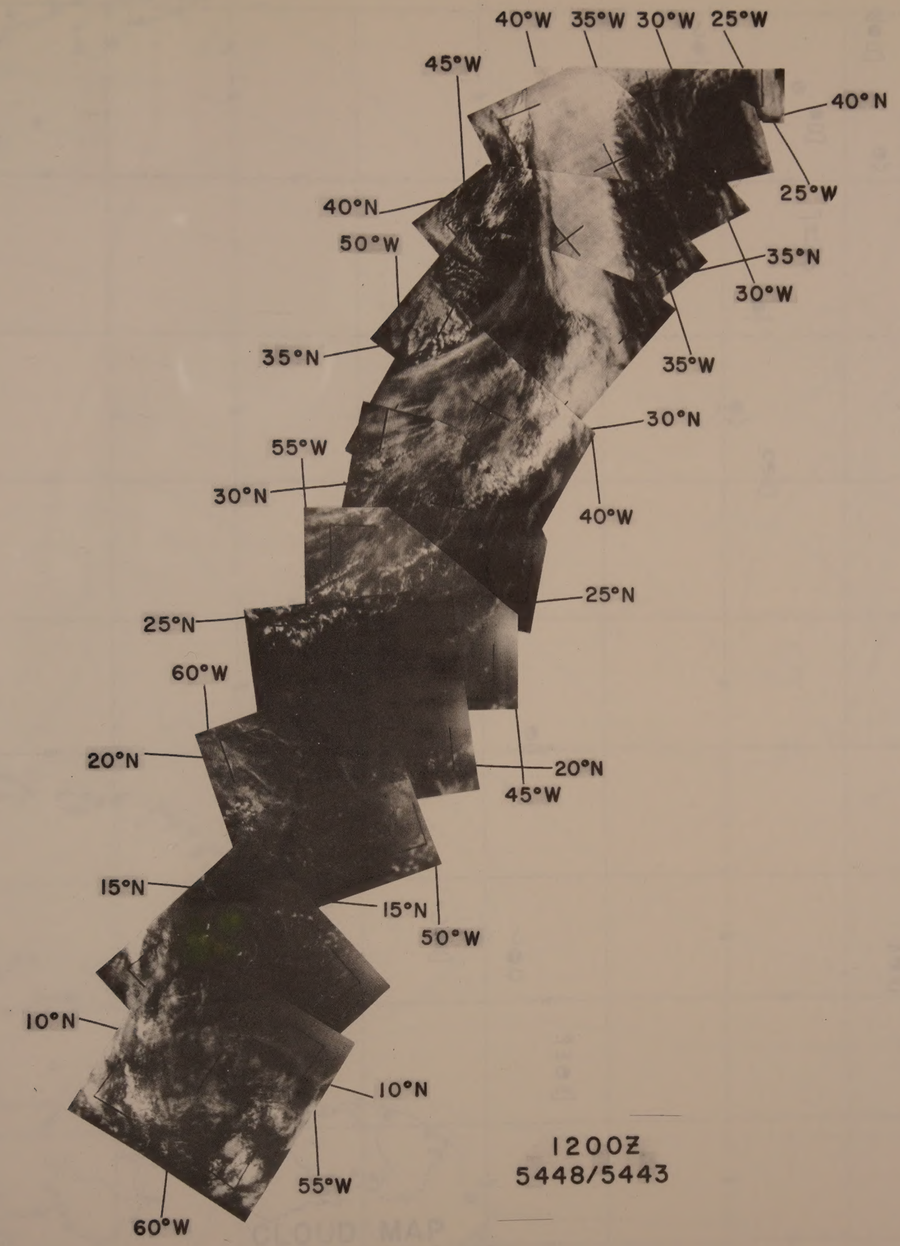
1130Z
1465/1464



0950Z
1464/1463



0813Z
1463/1462



1200Z
5448/5443

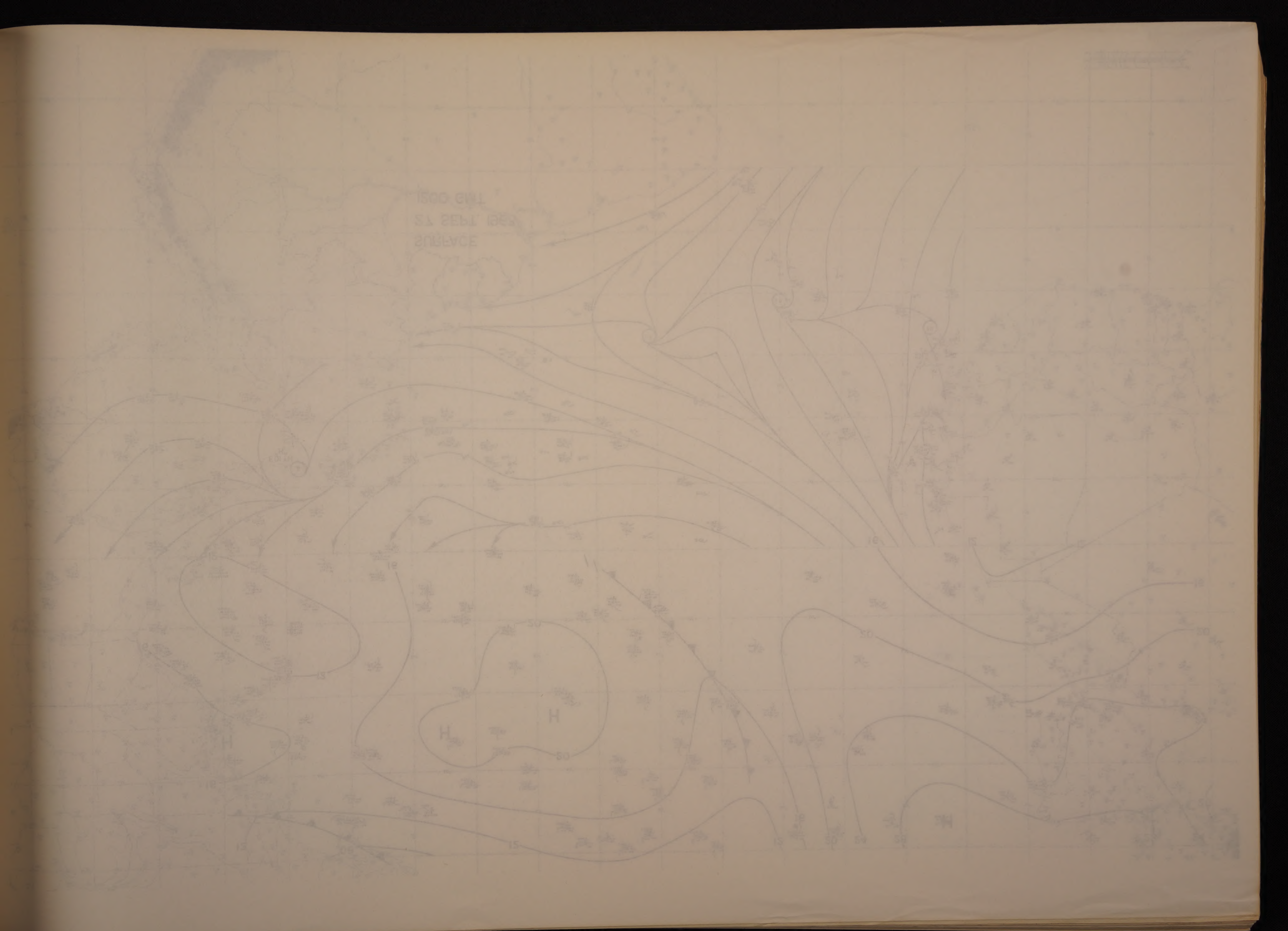
26 SEPTEMBER 1963

CLOUD MAP
26 SEPT. 1963
1200 GMT

EDITH
"H"

200 MB
26 SEPT. 1963
1200 GMT

SURFACE
27 SEPT. 1963
1200 GMT

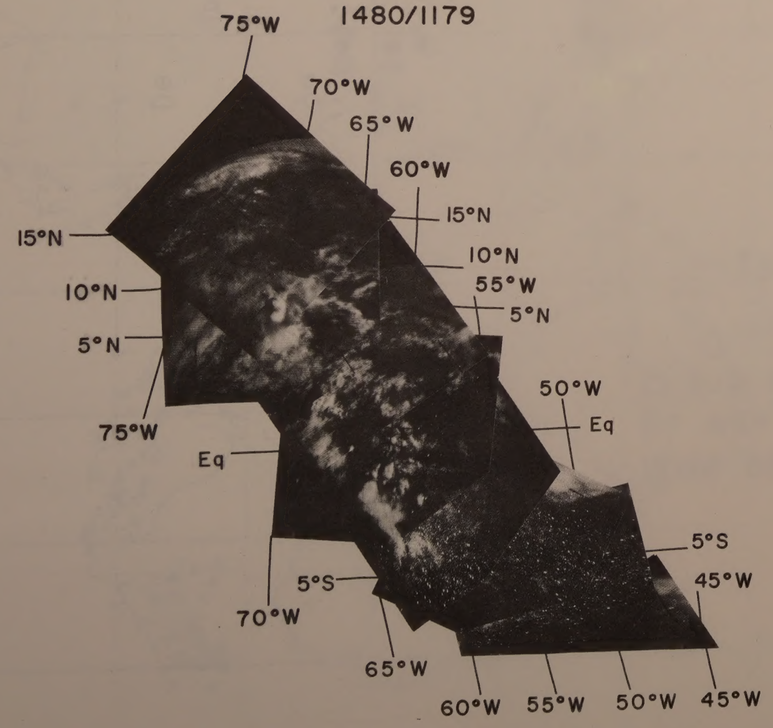

H
H
H
15
15
15

1243Z
5463/5458

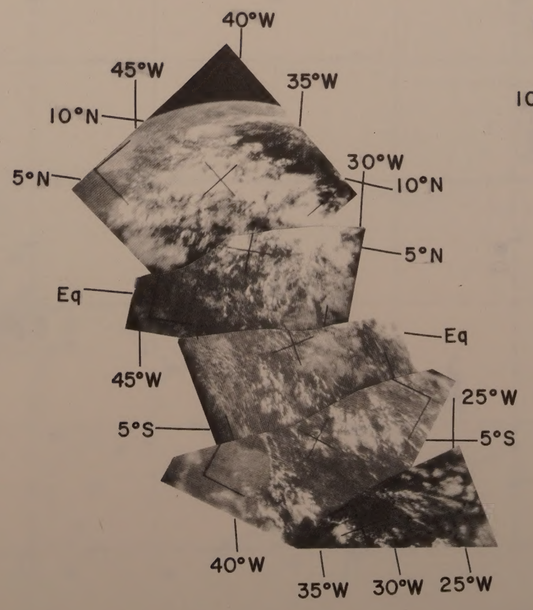
27 SEPTEMBER 1963

27 SEPTEMBER 1963

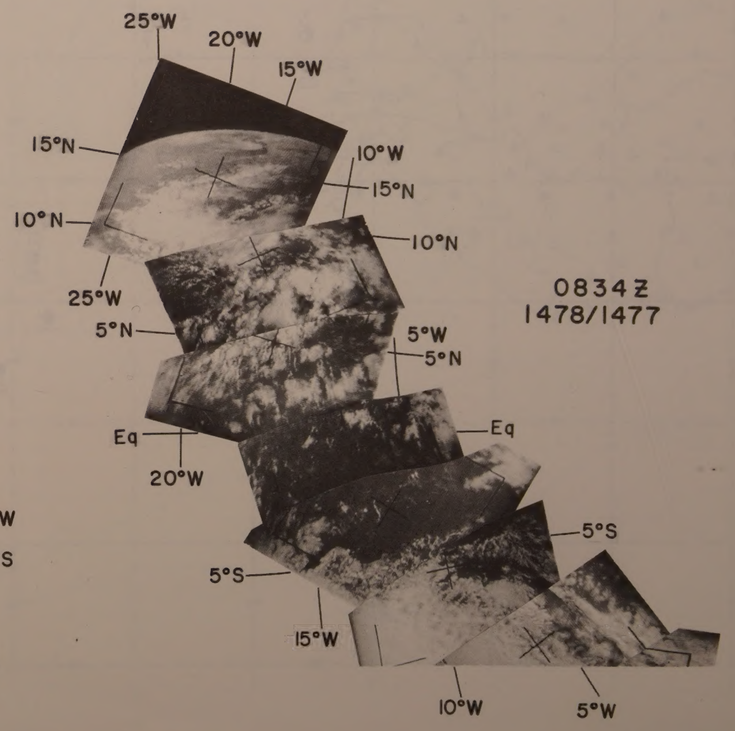
1149Z
1480/1179



1014Z
1479/1478



0834Z
1478/1477



CLOUD MAP
27 SEPT. 1963
1200 GMT

EDITH

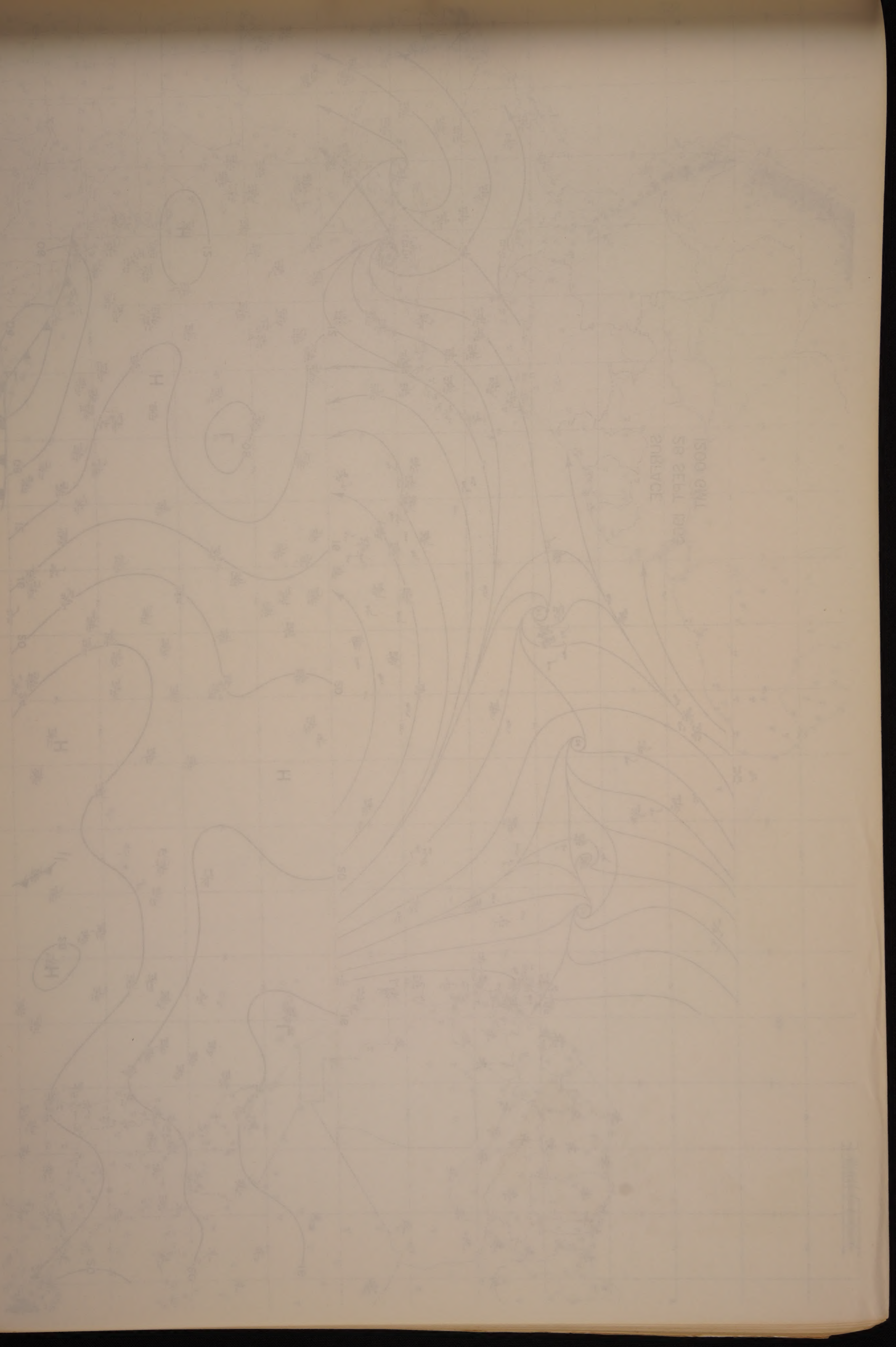
200 MB
27 SEPT. 1963
1200 GMT

EDITH

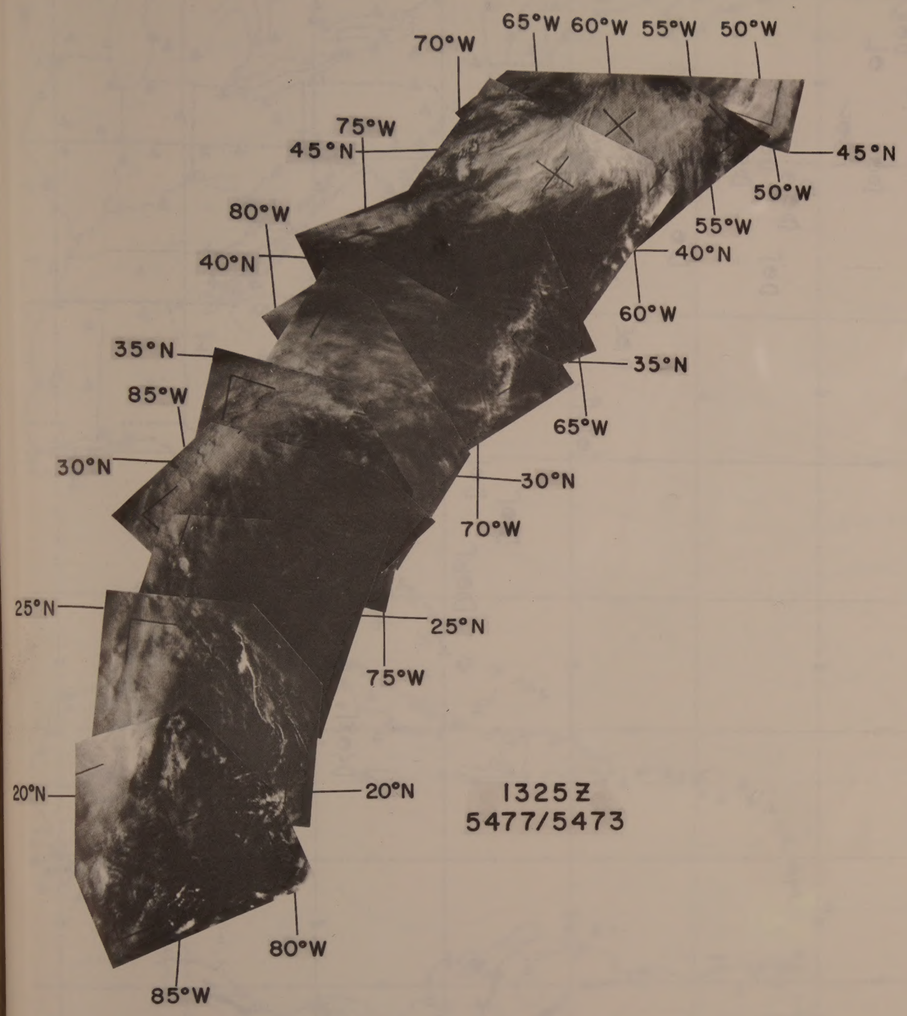
SURFACE

28 SEPT. 1963

1200 GMT

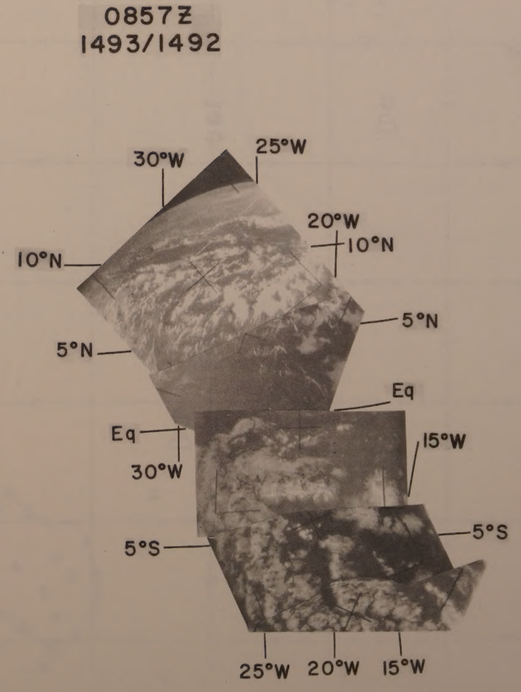

SINGULAR TRIPLE POINTS
TWO-FOLD

28 SEPTEMBER 1963

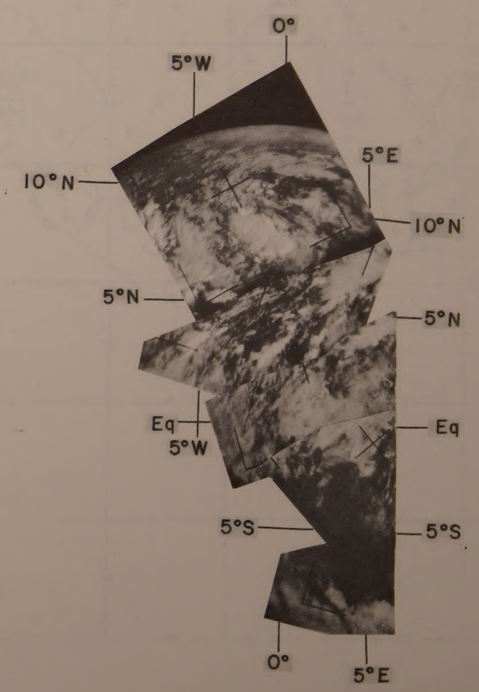


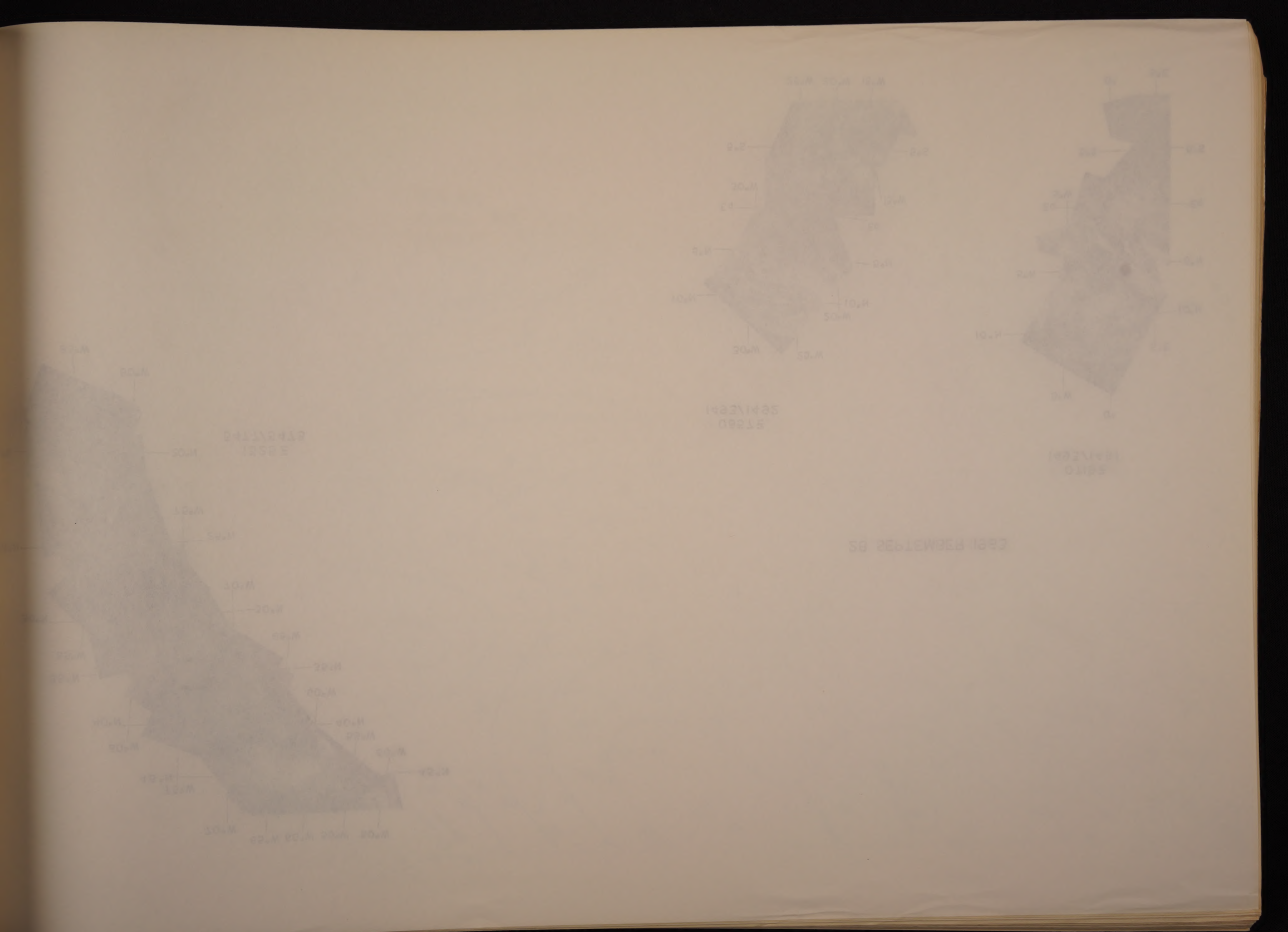
1325Z
5477/5473

0719Z
1493/1491

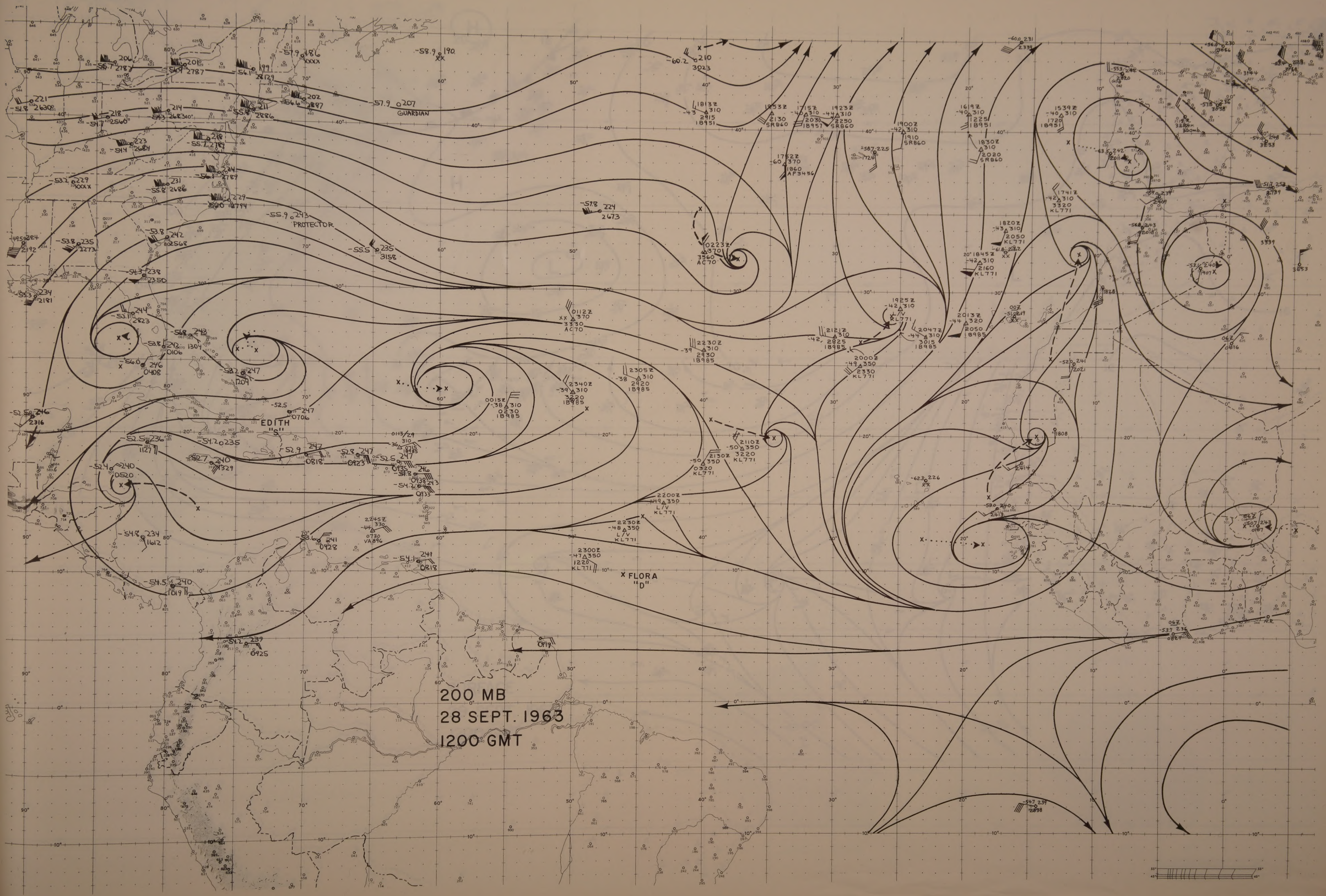


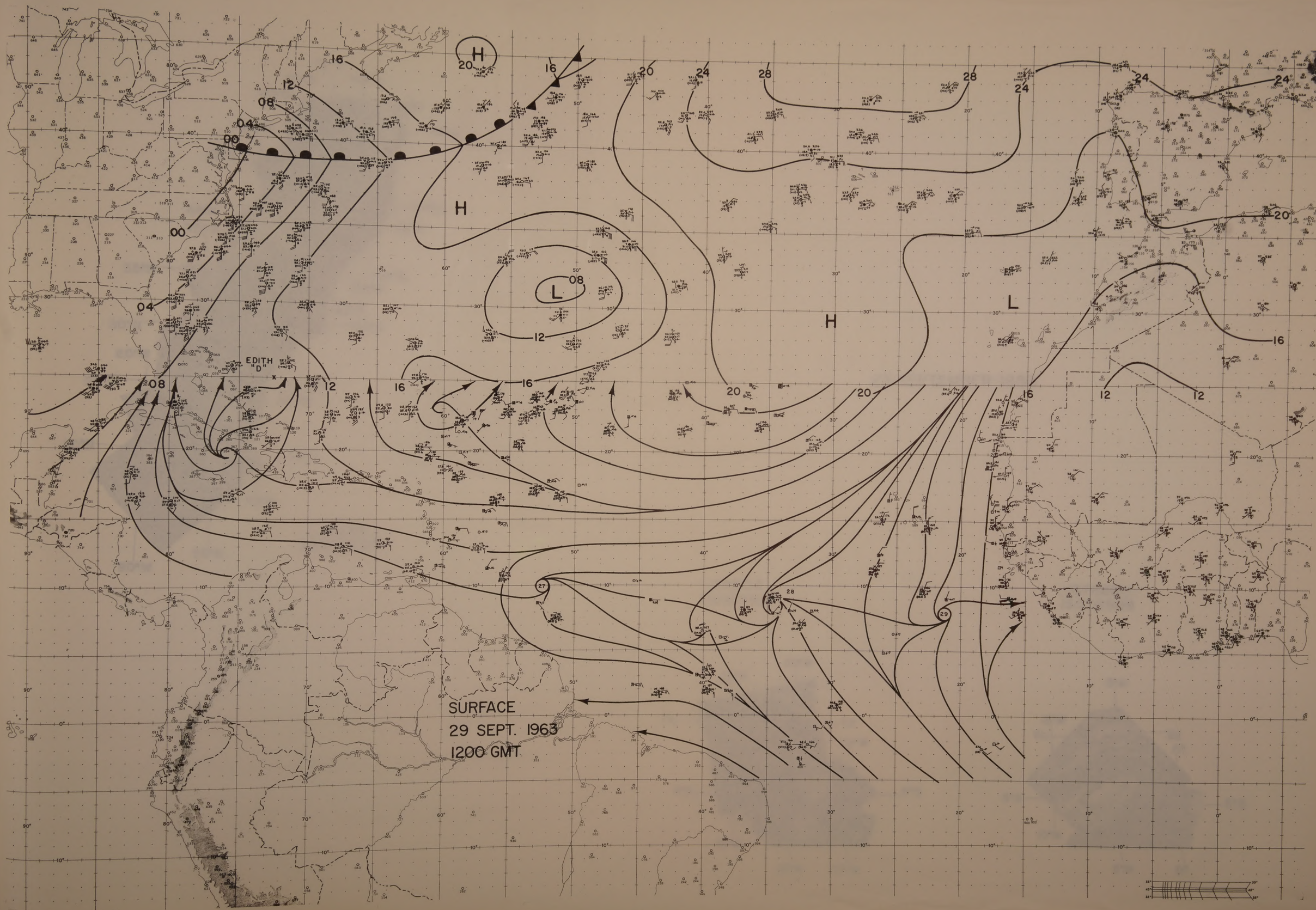
0857Z
1493/1492

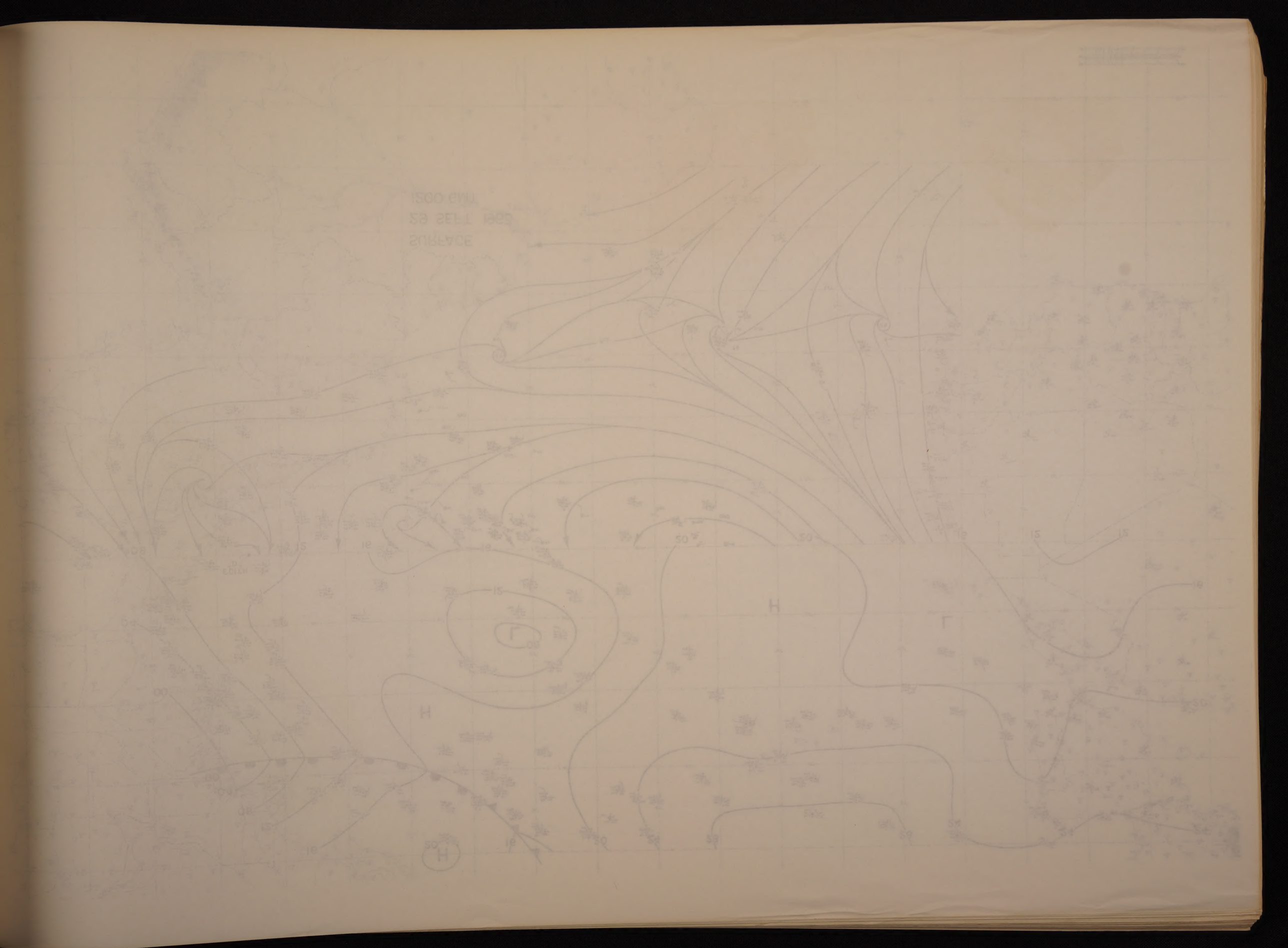




CLOUD MAP
28 SEPT. 1963
1200 GMT


EDITH
"S"
FLORA
"D"
PROTECTOR
GUARDIAN
200 MB
28 SEPT. 1963
1200 GMT

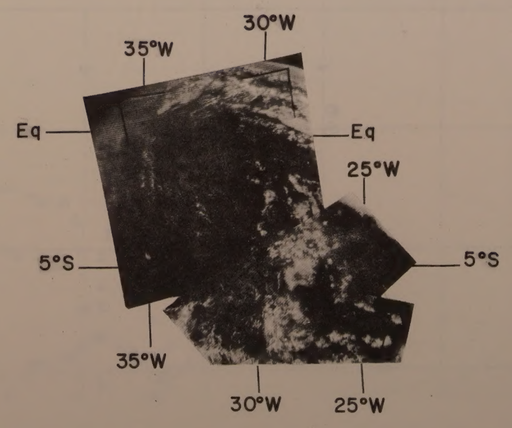

H
L
H
L
H
EDITH
"D"
SURFACE
29 SEPT. 1963
1200 GMT



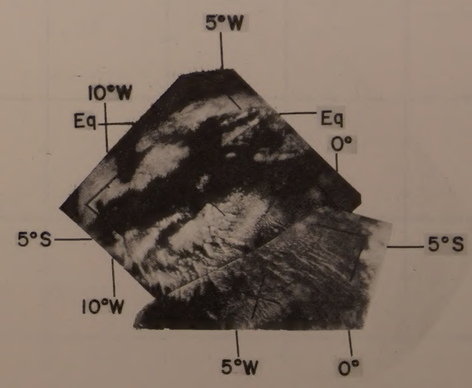
29 SEPTEMBER 1963

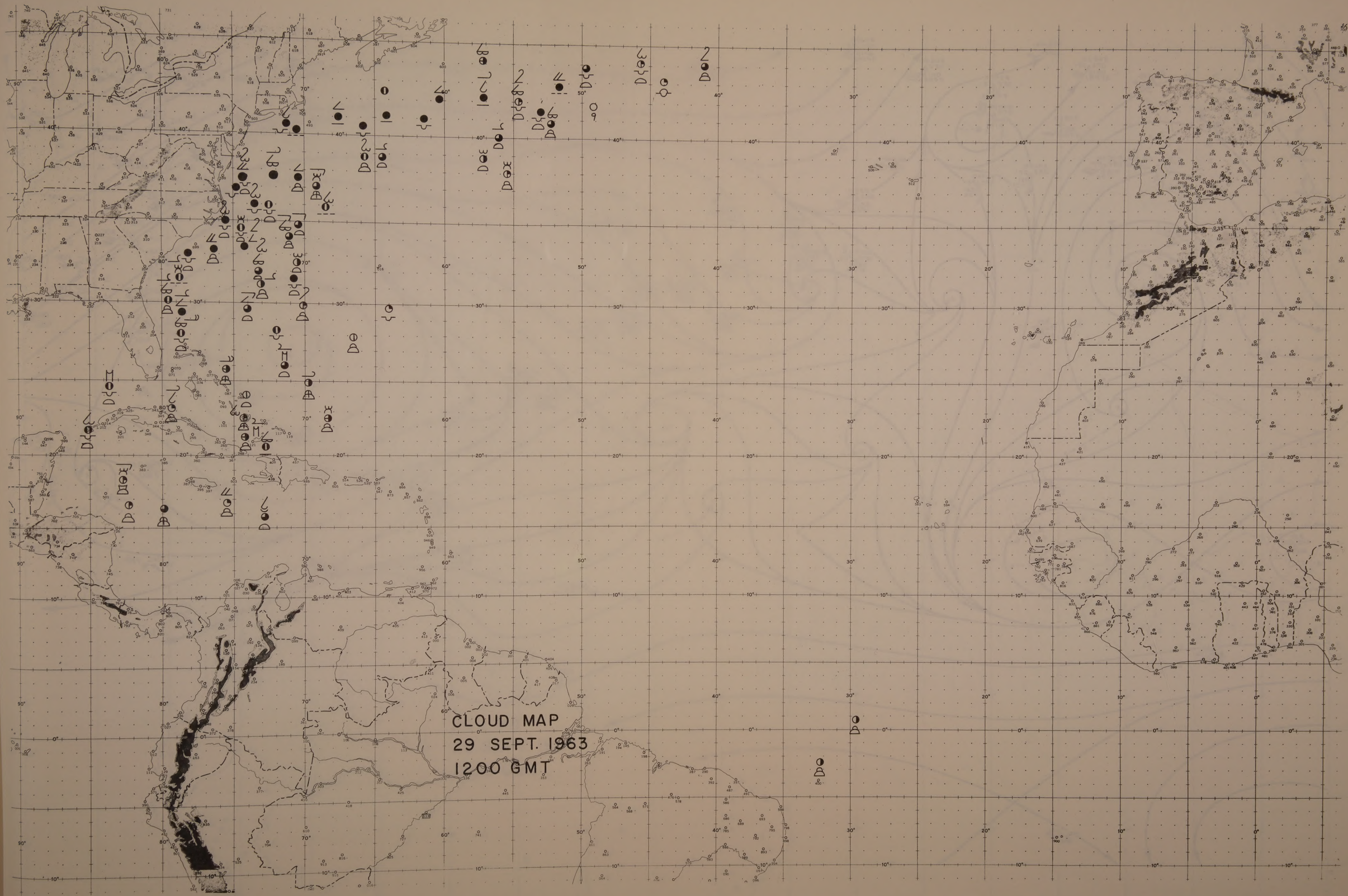
1229Z
5491/5487

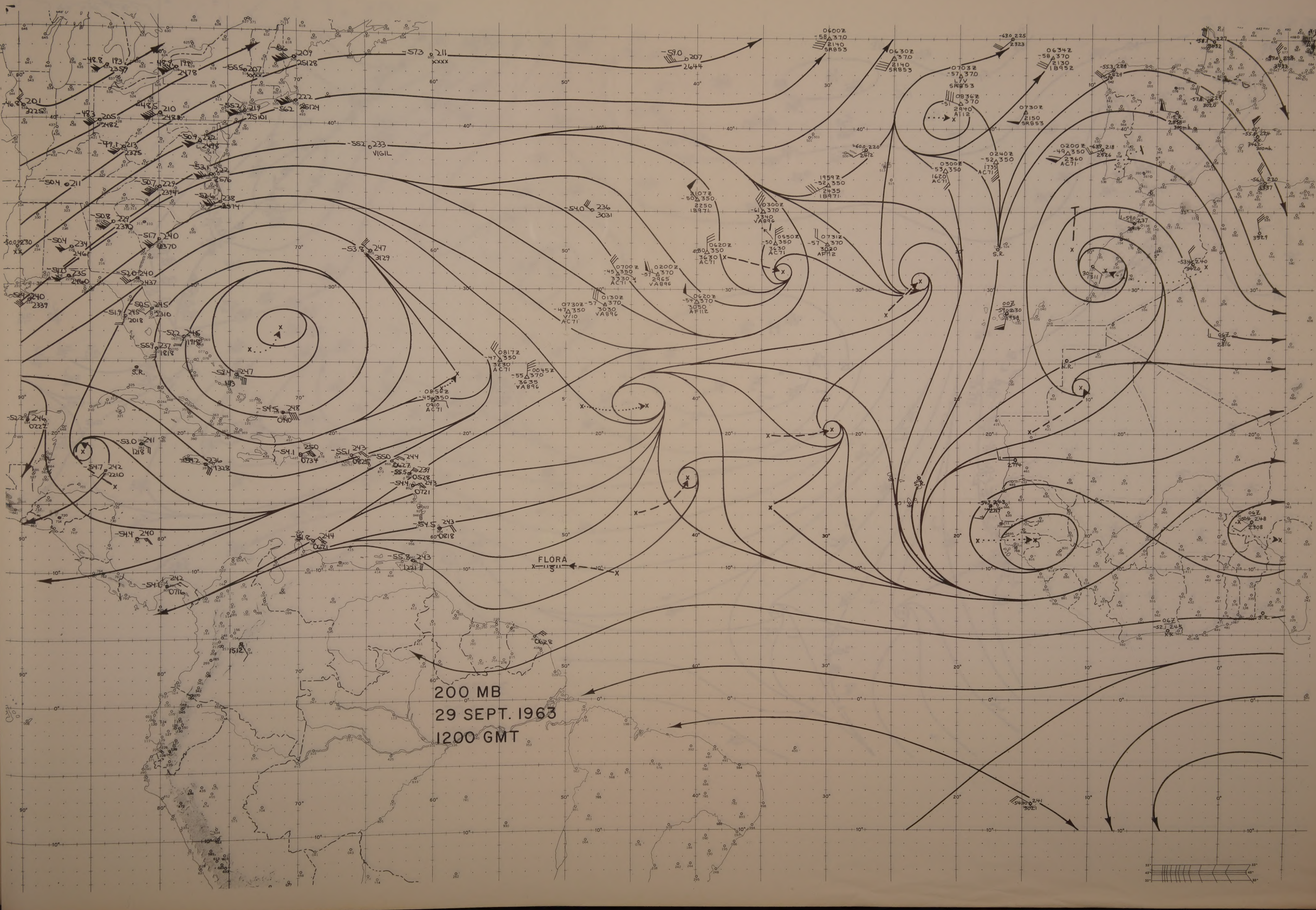
0920Z
1508/1507



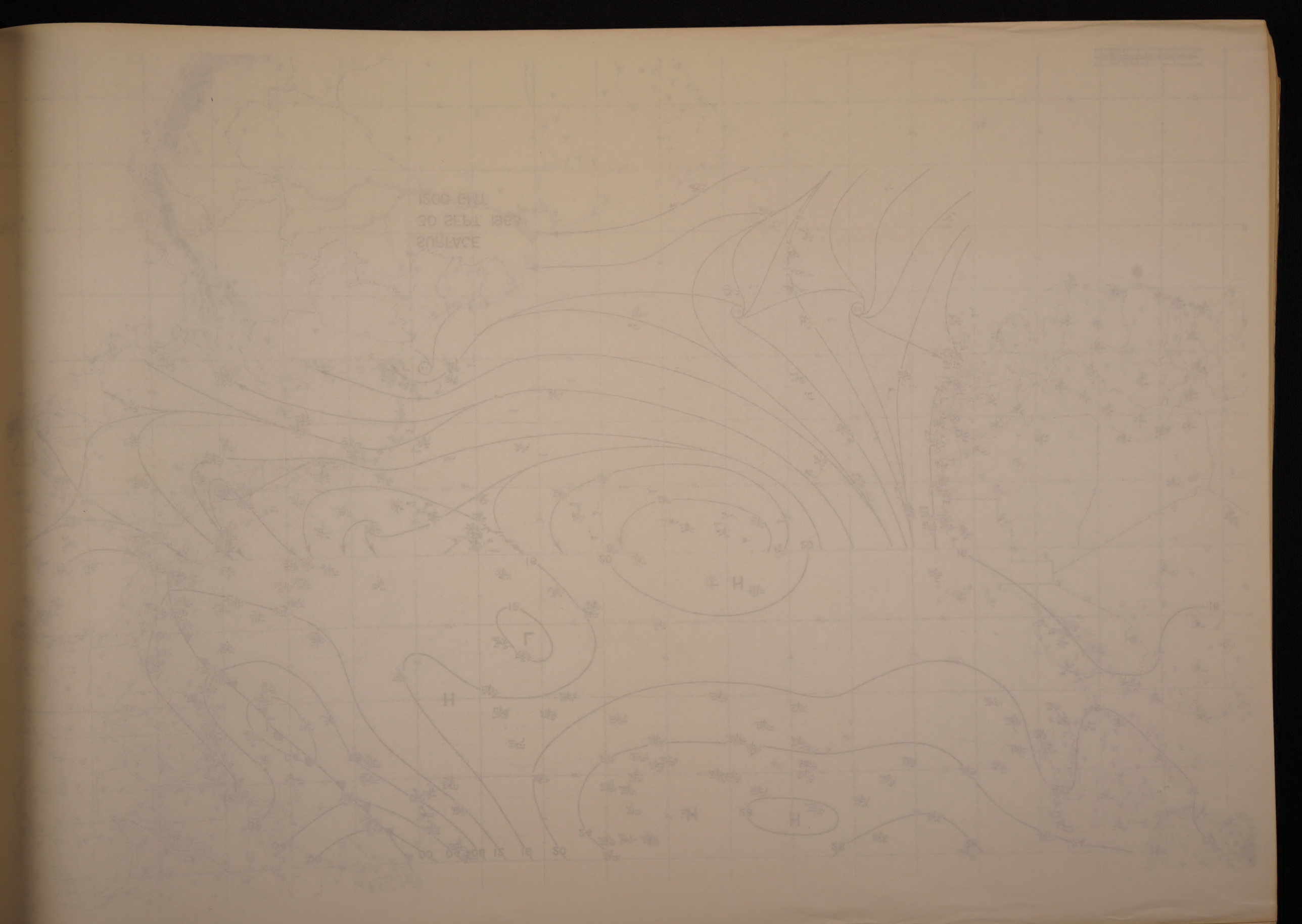
0743Z
1507/1506




CLOUD MAP
29 SEPT. 1963
1200 GMT


200 MB
29 SEPT. 1963
1200 GMT
FLORA
S.R.
VIGIL

SURFACE
30 SEPT. 1963
1200 GMT


SURFACE
H
L
H
H

200 MB
30 SEPT. 1963
1200 GMT

UNIVERSITY OF ALBERTA LIBRARY
0 1620 1656 5978